



TECHNICAL UNIVERSITY OF CLUJ-NAPOCA

ACTA TECHNICA NAPOCENSIS

Series: Applied Mathematics, Mechanics, and Engineering
Vol. 65, Issue Special I, February, 2022

RAILWAY TRANSPORT MANAGEMENT IN THE COVID 19 ERA AND THE ECONOMIC SOCIAL IMPACT OF THE PANDEMIC ON THE RAILWAY INDUSTRY

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***Abstract:** This paper presents the effects of the Covid-19 pandemic at national and European level on the activity of the railway transport sector and the countermeasures necessary for the recovery in the post-Covid era. The Covid-19 pandemic could be the opening to a new mentality in the field of transport and the way to embrace a new mobility. Following the evolution of the epidemiological situation caused by the spread of the SARS-cov-2 virus, on March 11, 2020, the World Health Organization declared a pandemic, which pushed most governments to take measures to limit the spread of the new coronavirus. These measures affected and had a negative impact on the entire economies, including the railway industry, which was severely affected due to the restriction of the movement of people and the quarantine of some localities. The demand at the level of the railway transport market has decreased dramatically, as well as the benefits and implicitly the revenues.*

***Key words:** railway transport, management, Covid-19, mobility, digitalization.*

1. INTRODUCTION

The Covid-19 pandemic has substantially affected the rail sector in the short term with a sharp drop in traffic, but it will also have long-term effects. With the passage of time and the end of the pandemic, we can expect behavioral changes in travelers, new routines and technologies that will be used (1).

The design of the rolling stock, as well as the services offered will look completely different. The rapid spread of COVID-19 virus, which has become a global pandemic in a matter of weeks, has been attributed to the hypermobility of our current lifestyle, globalization, connectivity and accessibility (2).

Globally, restrictions due to the pandemic have led to a reduction in passenger volume of around 80% for all railway markets. For international rail passenger services, the volume of passengers decreased by almost 100% for all operators, in line with the closure of

international borders. Regarding the transport of goods, the volumes were affected with an estimated loss between 10-15% for most operators (3).

The impact on rail freight transport is much lower and incomparable with that of passengers, because activities differ, and blockages during the Covid-19 crisis have given rise to migration from road to rail.

While many borders were closed to passenger traffic, they remained open for freight.

The decrease in freight traffic is also due to the decrease in production in some countries, due to restrictions, propagating directly in the decrease of transports.

2. ANALYSIS OF THE IMPACT GENERATED BY THE COVID-19 PANDEMIC ON THE RAILWAY SECTOR

The crisis generated by the new coronavirus has directly affected the economy, with the

entire activity of the rail transport sector being overwhelmingly affected.

All European countries, including Romania, in order to prevent and limit the spread of the Covid-19 virus, had to take measures to limit the effects of the virus spread, which severely affected the demand on the rail transport market and beyond.

If we follow the evolution of the impact of restrictive measures, we will see the beginning of the decrease in the number of passengers-km, in the first quarter of 2020, when the pandemic was declared by the World Health Organization, the impact being much stronger in the second quarter of 2020, the number of passengers decreasing in most European countries by more

than 50% compared to the data recorded in the first quarter of 2019.

The countries that have registered the largest decreases in the demand for rail transport are (4):

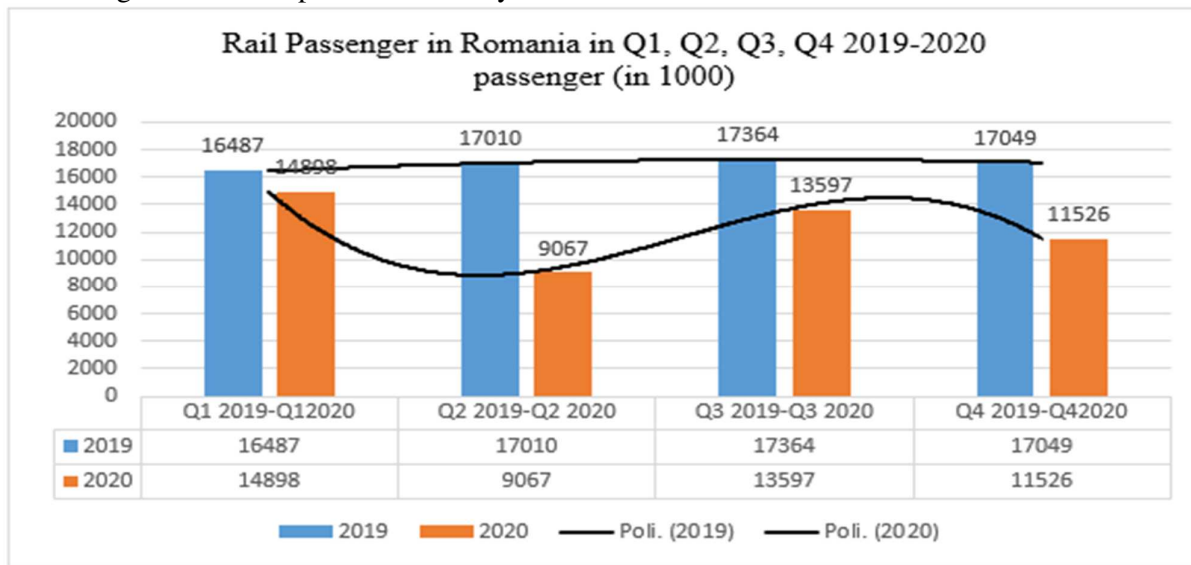
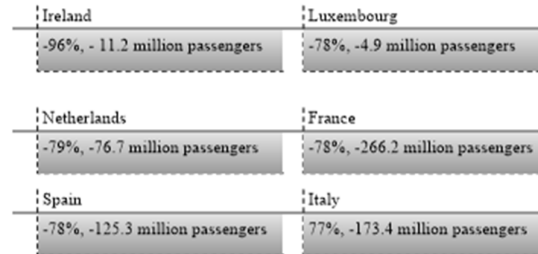


Fig. 1. Impact of restrictive measures on the number of passengers in the Romanian railway sector compared to 2019 (data source: (4))

Despite the easing of restrictive measures and a slight increase in the number of passengers in the third quarter of 2020, the decline in transport



demand continued in the fourth quarter of 2020 in all European countries.

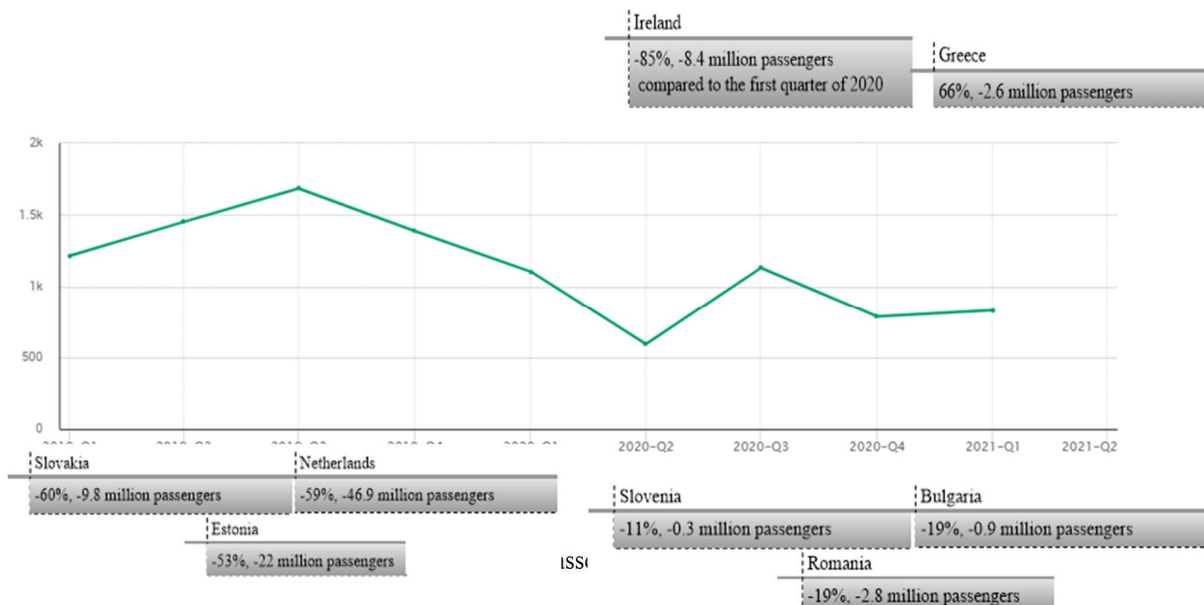
In the 4th part of 2020, the demand for rail transport decreased the most in the following states:

The smallest decrease in the number of passengers took place in:



In the first half of 2021, the number of rail transport users also remained significantly lower than in the same period of the previous year, when the pandemic had not yet made a definite impact on our lives.

The largest decrease in the demand for rail transport was identified in:



It can be seen in figure no. 2 a variation in the number of passengers depending on the pandemic waves.

Due to the decrease in the number of travelers and the economic impact was one to measure, registering a drastic decrease in revenues from the sale of travel cards.

A graphical representation of the worldwide losses are shown in figure no. 3.

We can observe losses of over 36 billion USD in the first half of 2020, the decrease continuing in the second half, but with a smaller impact, namely 23 billion USD, resulting in total annual losses of about 60 billion USD.

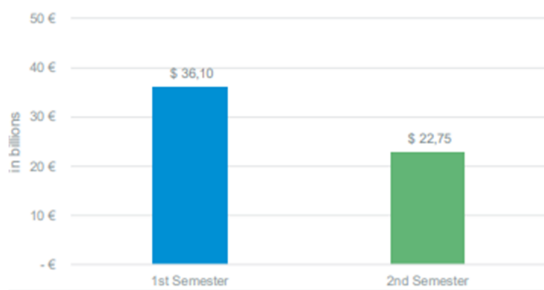


Fig. 3. Estimating the global economic impact on the railway sector (3)

In Romania, the economic situation generated by the impact of the Covid-19 pandemic on the activity of the National Railway Passenger Transport Company „CFR” Calatori S.A., is also negatively influenced,

registering a decrease in revenues collected compared to 2019 (figure no. 4).

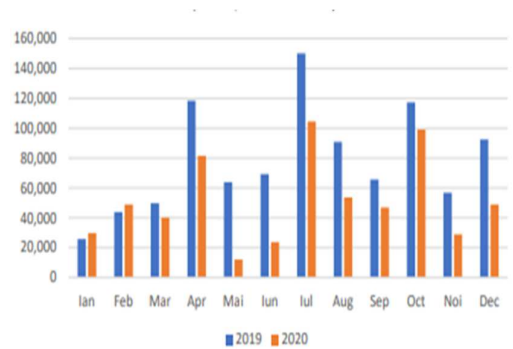


Fig. 4. The monthly evolution of the incomes (thousands of RON) from the sale of travel cards in 2019 vs. year 2020 (5)

Globally, the largest losses occurred in Asia, followed by Europe, in other parts of the world, the losses are less significant, because rail passenger transport does not play such a large role in the rail market (figure no. 5).

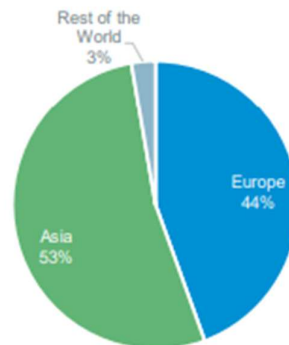


Fig. 5. Percentage of lost revenue due to the decrease in the number of passengers in 2020 (3)

Following the analysis performed, we can observe the impact of the Covid-19 pandemic generated on the railway sector, both in terms of the number of passengers and the revenues received from travel.

The return of the railway industry to the pandemic era is a mission of major importance, which must be based on regaining the confidence lost by passengers, as well as how to manage the barriers due to the behavioral change generated by the pandemic.

3. CHANGES IN THE PANDEMIC ERA ON RAIL TRANSPORT MANAGEMENT

One of the main concerns of the fight against coronavirus has an impact on the ability to combat the other crisis we face: climate change and the role of the transport industry in this crisis. If the economic problems generated affect investments or regulations in this regard, this could make it more difficult to fight greenhouse gas emissions.

In China, where the pandemic began, there has been an increase in car sales as people start turning to private vehicles due to health safety issues. In the UK, people's affinity for public transport is also declining.

According to studies, it has been found that people believe that owning a vehicle will be more important in the future, to the detriment of public transport.

On the other hand, significant behavioral changes have been found, such as teleworking and greater dependence on digital technologies, which have reduced transport demand and therefore emissions. Reducing the need for travel, especially for commuters, should not be a bad thing for the railways.

Proper management of the situation created by the Covid-19 pandemic could bring significant environmental gains, but only if the railway industry is proactive to ensure that there is no modal shift towards the use of private vehicles (6).

In this context, there is a risk that people will turn their backs on public transport and return to the use of personal vehicles, due to the feeling of

personal safety and flexibility of travel, despite all efforts to promote sustainable mobility.

The digitalization of transport through IoT and 5G technology could be a response to the changes caused by the pandemic and the mobility needs of people.

In conclusion, the aim is to reduce large investments in hardware and, instead, to develop intelligent, convenient and efficient software solutions.

One of the big challenges is to make rail transport a safe mode of transport in times of crisis such as a pandemic and to increase the confidence of commuters and other passengers.

Another major challenge is to reverse the modal poles of transport and people's perceptions of public transport, making it possible to migrate from private to public transport and from road to rail.

In this sense, lies the need for a modern transport infrastructure by implementing new technologies and providing safe mobility. Identifying and providing alternatives to current modes of transportation is necessary.

The pandemic caused a shock to the system which caused a sudden reduction in the performance of the railway sector with consequences in its basic functions. This requires the development of concepts and methods for assessing the resilience of the system over time, including the impact on public health, accessibility, equity, sustainability and financial viability (7).

The implementation of 5G technology and other advanced technological systems in the future can provide faster connectivity and a much greater capacity for data transfer and storage with the advent of IoT (Internet of things) applications, which could be developed in the railway industry.

The applicability of these new technologies can lead to cities, infrastructure, trains, intelligent railway stations, railway systems connected by IoT technology, etc..

The implementation of artificial intelligence in the transport sector connects sensors, devices, people and operations for data collection for predictive, analytical, control, health, safety, security and autonomous applications through 5G synchronization systems (8).

5G applications have already been implemented in the fight against the Covid-19 virus, for example, to monitor the conditions of passengers in stations, airports, multimodal centers, etc., and infrared temperature measurement based on 5G technology has already been used in various cities (9).

Apart from these new approaches that the railway transport system should implement in order to cope with the period it is going through and to provide a response according to the pandemic and post-pandemic situation, it is reinventing or returning to normalcy.

Railway management must be directed towards a sustainable recovery from all points of view and that offers a firm response to all current and future challenges and threats, while embracing the mobility of passengers.

The main objective of the management of the railway sector must respond to the needs of passengers in difficult conditions such as this period of crisis we are going through, but also the possibility to adapt to future crises.

Passengers' confidence in the public transport system, due to the pandemic, is relatively low, as they embrace the idea of owning their own vehicle, having the perception of a safer journey in terms of health.

The pandemic offers us a unique opportunity to rethink the transportation system and move it to a more resilient, fair and hassle-free experience.

This situation represents the time to use the Covid-19 pandemic as an opportunity to demonstrate the quality and strength of the rail system to return to the forefront (10).

In a post-pandemic future, the main goals of transportation companies and operators will be the safety and security of passengers and transportation so that people can travel again without fear.

In this sense, companies and governments will have the chance to redesign the way systems work, making them more attractive in terms of security and more (11).

The future of the railways depends on the management of the new challenges, but also on the role that the railway can play in the mobility of the continent.

In order to face the future crises, the railway transport management must follow the steps recommended by the European Union, namely:



The resilience of the railway transport system is defined as the ability of a railway system to provide efficient services under normal conditions, as well as resistance, absorption, accommodation and rapid recovery after disruptions or disasters (12).

Recovery is the system's ability to cope with the evolution of threats and to recover quickly, prevent and recover.

Reinvention refers to the reinterpretation of the „new normal”, the maintenance of quality and the increase of competitiveness. At this point the need for research and innovation is necessary, as well as the implementation of policies to promote new technologies.

The reform lies in the need for environmental policies, ecological solutions and recovery from this point of view.

The review aims to provide innovative solutions in railway technologies, alignment of needs and efforts on digitization and automation of processes and research of digital solutions to combat future threats by implementing IoT in the railway industry (13).

4. HOW 5G AND IoT TECHNOLOGY CAN CONTRIBUTE TO RAILWAY SYSTEM QUALITY REVOLUTION?

5G technology can contribute a lot in the reinvention of the railway system and has a very wide spectrum of use and applicability.

It is a revolutionary technology that allows networks to operate at a high level and will contribute to the transformation of transportation systems, health, agriculture, production, entertainment and other industries.

This technology can be defined as a combination of speed and responsiveness, connects people, machines, automated processes and will provide solutions to many challenges of society.

The use of this technology includes the Internet of Things (IoT), artificial intelligence (AI), augmented and virtual reality (AR and VR) and edge computing.

Although these technologies exist today, the networks that currently support them limit their full potential.

The technological advances that 5G allows will differ depending on the industry and application.

However, all will enable data and communication solutions to create more efficient and sustainable technological processes, improve consumer services and improve the quality of life of users (14).

The main advantages brought to the railway transport system by 5G technology through the Internet of Things (IoT):

- mobility: an important factor for economic development, social cohesion and the creation of a transport network interconnected by multimodal transport, where the railway sector can make a major contribution;
- fighting the capacity constraints of congested railway networks by finding sustainable ways to increase capacity through digitization and implementing 5G, IoT technology, without the need to modify current networks.

5G technology will allow a shorter distance between two trains, so that on a traffic distance there can be two trains at the same time, which until now is not possible (at the moment the principle of impenetrability is respected, ie it can be found at a given time only one train on a circulation distance delimited by sectioning points, the tracking interval being a predetermined one).

Thanks to new technologies, trains will be able to "communicate" with each other (train-to-train) and can travel together over a certain distance (15) (16).

- increasing user satisfaction and perceived quality by providing digital solutions, connectivity and safety in intermodal terminals, railway stations, trains, etc.

- advanced communications services along railway networks (lines, stations, tunnels, difficult areas) where coverage is low, as is the case today with 4G (15).

The speed of sending and receiving information can be up to 1 millisecond. 5G technology can be up to 200 times faster than 4G and with a reliability of 99.999%.

This technology can transfer large amounts of data very quickly with a maximum transfer rate of up to 10 Gbps, which until now could only be done using a wired connection, being a disadvantage for many areas (16) (17).

- detecting high temperatures in a flow of moving people, which is a major symptom of the Covid-19 virus, and monitoring and collecting the movements of potentially infected people using artificial intelligence (AI) (18).

The main improvement initiatives due to 5G technology for passengers will be:

- speed of ticket purchase and simple readability of tariffs;
- electronic tickets and fast scanning;
- free high speed and uninterrupted WiFi.

Thanks to 5G, on-board train connectivity will be faster and more reliable and will make it possible to implement new ticketing systems, which offer passengers quick access and safety in the current health conditions and to obtain personalized promotions or offers.

It will also be possible to monitor crowds at ticket offices, which can help passengers avoid congestion at railway stations and trains.

For railway operators the main improvements can be classified into:

- communications in critical environments;
- increased bandwidth and high speed communications;
- IoT communications.

The introduction of new technologies such as the Internet of Things (IoT) and 5G offers new possibilities for controlling train traffic and monitoring railway infrastructure.

The advantages of implementing new technologies are many, including: forecasts of rail traffic on the network, the ability to coordinate train traffic on the network to eliminate blockages, monitoring energy consumption and wear of rolling stock and infrastructure.

All these advantages will make possible the transition to a predictive maintenance of the rolling stock and the infrastructure.

Improving services through 5G technology for railway operators can be classified into three branches:

- 1) Critical services: safety of operations, traffic and security of transport, traffic monitoring, infrastructure maintenance, hazard prevention;
- 2) Performance services: improving the efficiency and effectiveness of the railway system, through IoT;

- 3) Business services: electronic tickets, promotion of customer services, travel offers and promotions

All these benefits of the 5G network implementation mentioned above lead to:

- increasing safety and security at stations and means of transport (monitoring passengers, detecting attacks, combating Covid-19, etc.);
- increased efficiency and effectiveness for all system factors;

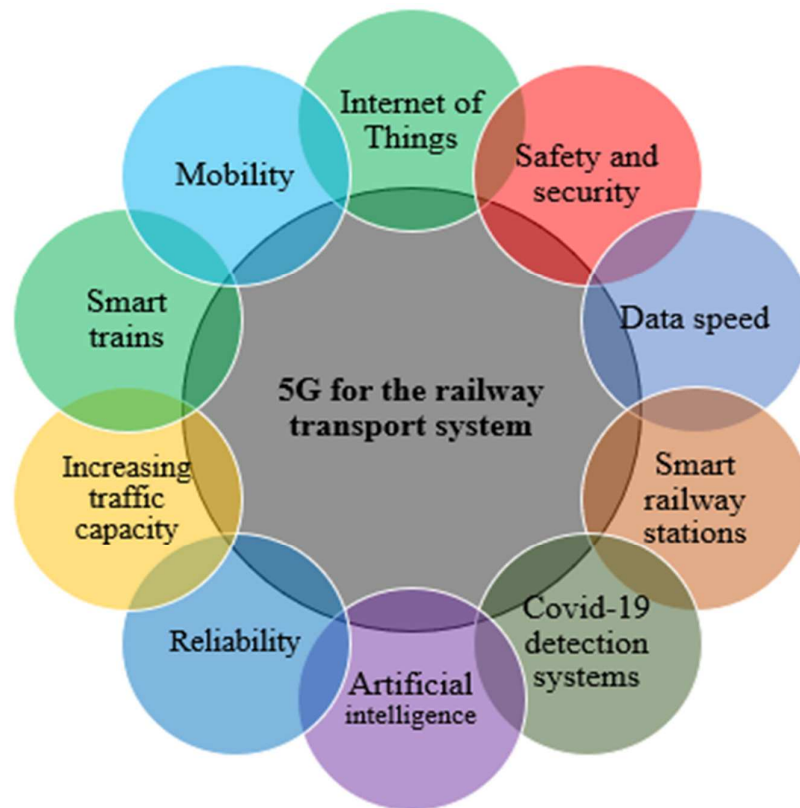


Fig. 6. The contributions of 5G technology in the railway industry

- improving passenger services, increasing the competitiveness and attractiveness of the transport system (19).

Data collection and safety, confidentiality and security remain a challenge for the application of 5G technology and everything related to it in the railway industry.

The advancement of technologies and investments in infrastructure will pave the way for new technologically advanced means of

transport such as autonomous trains or hyperloop trains.

Therefore, it is expected that after COVID-19, there will be an acceleration of migration to the railway due to climate awareness and because the railway system is safer.

Innovative technologies such as IoT, 5G, etc. helps fight the COVID-19 pandemic and increase efficiency, improve safety, security and health in organizations.

5. CONCLUSIONS

The Covid-19 pandemic has severely affected the rail transport sector, but this may be an opportunity to develop and adapt to the new challenges of the rail industry.

For the railway sector, this crisis caused by Covid-19 may be the time to reset, improve competitiveness and adopt a new vision oriented towards mobility, digitalization and the adoption of ecological measures.

Increasing the attractiveness of rail transport must be part of strategic management in the Covid-19 era.

Railways can play an important role in ensuring sustainable mobility, also limiting the spread and effects of the pandemic.

In this context, it is vital for the protection of the environment and mobility to move from ecologically unsustainable modes of transport to environmentally friendly modes of transport.

Rail transport can support policies on the use of alternative solutions to fossil fuels and the development of an environmentally friendly system.

The covid-19 pandemic is giving a boost to the digitalization of rail transport and increasing its attractiveness.

The railway industry needs to orient itself and adopt initiatives to digitize services and promote them by incorporating them into national development strategies.

In principle, any strategy must at least define the strategic objectives and identify solutions to achieve these objectives.

In particular, it must be borne in mind that rail transport is a matter of national and European interest.

As a result, the strategy objective for the development of the railway industry derives from the national and European interest related to the efficiency and balancing of the transport system, an objective that leads to the need to develop the railway transport.

The issue of harmonizing the national and Community interests is a topical issue in the field of rail transport, where the Union's policy is to create a single European railway area which, on the one hand, is a pillar of the Union's economic integration and, on the other, to be a

foundation of economic growth in the community space.

The analysis of the current situation of rail transport also showed that there is great potential for increasing rail transport in the internal transport market.

In the case of passenger transport, the theoretical growth space visited both interurban public transport, currently performed by buses and coaches, as well as the possibility of attracting passengers who are currently performed by individual means of transport. In the case of freight transport, the most significant theoretical growth space is given by the market of small shipments which are currently transported almost exclusively by road.

The railway can become a significant player in this market again, provided that intermodal transport and transport in isolated wagons are rehabilitated.

The analysis of the current situation of rail transport highlighted that railway infrastructure has played an important role in limiting the competitiveness of rail transport.

However, the reciprocal is true, in the sense that the railway infrastructure plays a decisive role in the rehabilitation of the railway transport.

The general strategic objectives regarding the development of the railway industry are:

- Increasing the competitiveness of rail transport on the internal market;
- Integration in the single European railway area;
- Increasing the quality of services;
- Digitization.

Successful implementation of the development strategy of the railway industry is an essential condition for halting the decline of rail transport and reversing this trend.

By default, it is a condition for initiating the restoration of modal balance within the national transport system.

The impact of this health crisis has revealed several vulnerabilities in the system, which must be taken advantage of by turning them into opportunities for the future.

Carrying out these analyzes of current events is important in looking for an answer for the future, especially since they do not bend to the patterns of previous crises.

The railway industry must adapt not only to the health crisis but also to the other problems

facing the system, as well as the migration of users to other modes of transport.

Expectations for rail transport are high and the development of new technologies to replace and ease current habits is needed.

One of the most important challenges for the railway system is to implement revolutionary technologies to increase the quality, safety and security of transport.

In conclusion, the transport sector as a whole, as well as the railway sector, must offer transport solutions adapted to the pandemic crisis and develop a personalized response..

The need for research in this regard is important and can generate positive effects on the quality of life of each of us.

This paper opens the horizon to new directions of research in the field of rail transport and new technologies that could be implemented in this industry to deal with new crises and not only, but also to increase the attractiveness of this mode of transport.

The railway can be the answer to many problems we face, we just have to want and implement coherent and correct policies.

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Managementul transportului feroviar in era Covid-19 si impactul economico-social al pandemiei asupra industriei feroviare

Rezumat: In aceasta lucrare sunt prezentate efectele pandemiei de Covid-19 la nivel national si european asupra activitatii sectorului de transport feroviar si contramasurile necesare redresarii in era post Covid. Pandemia de Covid-19 ar putea fi deschiderea catre o noua mentalitate in domeniul transporturilor si calea catre imbratisarea unei noi mobilitati. In urma evolutiei situatiei epidemiologice determinata de raspandirea virusului SARS-cov-2, la data de 11 martie 2020, Organizatia Mondiala a Sanatatii declara pandemie, ceea ce a impins majoritatea Guvernelor catre adoptarea unor masuri de limitare a raspandirii noului coronavirus. Aceste masuri au afectat si au avut un impact negativ asupra intregilor economii, inclusiv asupra industriei feroviare, care a fost grav afectata datorita restrangerii circulatiei persoanelor si carantinarii unor localitati. Cererea la nivelul pietei transportului feroviar a scazut dramatic, de aseamena prestatiile si implicit veniturile.

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