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COVID-19 IMPACT IN TRANSPORT, AN ESSAY FROM THE RAILWAYS' SYSTEMS RESEARCH PERSPECTIVE



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EXECUTIVE SUMMARY

This essay analyses the possible impact that COVID-19 will have on the transport sector. It also gives the prospect on how the sector should approach the "new normal" which will follow the current health emergency and be resilient in case of future outbreaks. The paper identifies several impacts that are already taking place in different instances such as the global consumers' behaviour. Due to the current lockdown situation interaction between producers and consumers has changed radically, and the supply chain had to adapt to cover necessities of citizens. The effects of the outbreak have been profound in consumption, however a growth in eCommerce and digital services have gained in importance and it is supposed to continue growing. The pandemic also had effects on the transport sector, to the point that a new paradigm of mobility will be necessary to meet environmental demands. The crisis halted passengers' mobility and limited air and sea freight capacity significantly. On the contrary, long-distance trans-Eurasian rail lines have been untouched. The pandemic had positive impacts on the environment as well. However, the trend of low production of GHG emission is expected to reverse course once containment measures are lifted. Transport will have an important role in the predicted rebound effect of GHG emissions; thus, the development of green new mobility is essential.

Analysing the forecast of the transport sector, railways will have distinct advantages over other transport modes both during the acute phase of the pandemic and the "new normal". On the other hand, underuse of the rail sector can lead to a collapse of the urban transport system. Lastly, this paper introduces the concept of 5 "R" as the necessary steps the rail sector needs to undertake to play a significant role in tomorrow's mobility. These steps are Resilience, Return, Reimagination, Reform, and Research. In particular, the paper highlights research needs which are considered essential in enhancing rail competitiveness. In conclusion, this paper reminds that this historic event must be considered as an opportunity to truly establish rail as the backbone of the European sustainable mobility.

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BACKGROUND

China was the first country hit by the Coronavirus disease 2019 (COVID-19). In response to the outbreak, Chinese authorities placed Hubei and other provinces on lockdown, and restricted economic activity in areas that are crucially important to the national and international economy. With the expansion of the Coronavirus SARS-CoV-2 to other countries and European Member states, similar policies are now being implemented in Europe. Several millions of people have been recorded infected by the virus, and several hundred thousand have lost their lives worldwide.¹ The current coronavirus outbreak is the greatest humanitarian challenge the European Union has ever faced.

However, it is also an economic challenge. Looking at the case of China, which has significantly reduced the cases of COVID-19, it is possible to draw some conclusions on the magnitude of the effects of the imminent economic crisis in Europe. The Chinese industrial output contracted by 10.9% quarter on quarter in January-March, and the forecasts show that Chinese growth in 2020 will be a mere 1%. However, China is in the time of publication experiencing small fresh outbreaks due to imported virus cases over borders, which have led to increased border controls, re introduction of

¹ <https://www.worldometers.info/coronavirus/>

lockdowns and cautious attitude towards over-reactivation of the economy. In this turbulent and volatile situation, it is difficult to estimate how long the pandemic will last and how long will the current restrictions remain in place.

This paper analyses the impact that COVID-19 will have on the transport sector on the assumption that the current emergency will last until 2021. However, it also gives prospect on how the transport sector should approach the "new normal" which will follow the health emergency and be resilient in case of future outbreaks.

It is necessary to highlight that this scenario is characterised by relevant constraints to mobility until the end of 2021, and it could be compatible with the potential applications of preliminary research results. However, such a scenario would also be dramatic for the economies of many European countries (i.e. UK, France, Italy, Spain). In particular, a prolonged stop to touristic activities would precipitate in some these countries to exceptional levels of poverty, with extreme impacts on the tertiary sector and corresponding low levels of mobility.

This proposal refers to a phase of full and unconditioned operation of railway passenger systems, which has to be enhanced swiftly, by accepting temporary social distancing only where technically possible and necessary.

It is also necessary to highlight that emergency health measures will play a key role on the psychology of passengers regarding the possibility of restoration of a reliable plan for personal mobility against the present uncertainties and the fear of social intimacy, also beyond the actual potential risk. As such, railway transport and integrated public transport as a whole need to provide a seamless continuous experience both in space and time without physical or technological barriers. This proposal believes the future of integrated public transport and railway depends on the capacity of maintaining and increasing these attitudes. Ineffective, intrusive measures will act as limitations in the context of public transport and will reduce the natural advantages of rail as a seamless barrier-free experience and thus push end-users back to individual mobility or air transport.

This position against limitations to mobility reflects the risk assessment on COVID-19.² As in the first phase extreme measures have been put in place to safeguard national healthcare systems, these measures will have to be less omnipresent once the risk for the healthcare systems is over. As the European Centre for Disease Prevention and Control show, the risk of "severe disease associated with COVID-19 in the EU/EEA and UK is currently considered moderate for the general population". Therefore, measures should be focusing on "populations with defined risk factors associated with elevated risk" and not overestimate the risks COVID-19 involves for the general population. Before the virus outbreak, other risks were habitually and continuously accepted in daily life and particularly in the use of transport systems once compared with the exceptional benefits of sociality and freedoms. This correct and healthy approach to risk management has to endure in the future and not radicalise on extreme positions.

OBSERVED IMPACTS

IMPACT ON GLOBAL CONSUMER BEHAVIOUR

The current pandemic may not be able to stop globalisation but will rather influence the ways globalization will work for the upcoming period.

² <https://www.ecdc.europa.eu/en/current-risk-assessment-novel-coronavirus-situation>

The impacts the COVID-19 pandemic will have on consumers are expected to be profound. The interaction between producers and consumers will change significantly, and in this context distribution channels are expected to play a crucial role. Supply chains, in particular, have to adapt and be more flexible to cope with the current challenge and thrive. In most affected countries, people decided or were compelled to leave their homes as little as possible; thus the impact of COVID-19 outbreak gave a tremendous push to eCommerce sector, which only in Italy experienced a 97% and 101% growth in, respectively, the first and second weeks of lockdown. While it is still unclear how long this trend will last, China³, the United States⁴, France⁵, Germany and Sweden⁶ experienced a strong growth in the eCommerce sector. China is particularly noteworthy as the already high shares of eCommerce before the virus outbreak grew significantly even in rural areas.

What COVID-19 has shown is that passengers and goods traffic can still suffer serious setbacks, with implication on a global scale. However, looking at "new normal" it is clear the transportation sector will continue playing a fundamental role in tomorrow's society. Still, it will be necessary to transform and adapt transportation to allow recovery to take place.

IMPACT ON TRANSPORT SECTOR

The need for a new paradigm of mobility is evident from analysing whose sectors have suffered the most severe slowdown during the pandemic. Overall, the transport sector has been hit hard by the impact of COVID-19. Both passengers transport and freight suffered severe setbacks from the COVID-19 crisis. In general, before the virus outbreak, it was estimated that passenger transport would have grown by 42% between 2010 and 2050. Freight transport was expected to grow by 60% during the same period.⁷

Passenger transport within the EU Member States and between the European Union and the rest of the world has been partially or entirely closed.

Air transport has been one of the sectors which suffered most, as it has been one of the vehicles for the virus outbreak. Several airlines have grounded nearly all their fleet or are deploying passenger aircraft as freighters. Nevertheless, although freight forwarding is still possible in every region, it suffers from extremely limited connections. Overall, in fact, the crisis has limited the airfreight capacity between China and Europe to 40% of its original capacity.⁸

Road transport faced several problems as well, and its efficiency plummeted. When in March the Brenner pass was closed to passengers' transport and health controls were put in place, queues of up to 90 kilometres in length formed on the Italian side of the border. Land transport has been subjected to disruptions and slowdowns, as a result both of border controls for sanitary measures and driver's unavailability.

Taking into account the passenger transport, the importance of air and road transport on an EU-wide scale is clear. In 2016, passenger cars accounted for 82.9% of inland passenger transport in the EU, while motor coaches, buses and trolley buses accounted for 9.4%, measured by the number of inland passenger-kilometres (pkm) travelled.⁹ At the same time, more than 1 billion passengers travelled by

³ <https://digiday.com/marketing/coronavirus-outbreak-grinds-e-commerce-operations-buckle-increased-pressure/>

⁴ <https://www.emarketer.com/content/coronavirus-covid19-boost-ecommerce-stores-amazon-retail>

⁵ <https://www.statista.com/statistics/1102648/online-shopping-sales-increase-corona-virus-outbreak-france/>

⁶ <https://www.digitalcommerce360.com/article/coronavirus-impact-online-retail/>

⁷ <https://ec.europa.eu/transport/sites/transport/files/2019-transport-in-the-eu-current-trends-and-issues.pdf>

⁸ <https://www.forbes.com/sites/wadeshepard/2020/03/31/china-europe-rail-is-set-to-boom-as-covid-19-chokes-air-sea-and-road-transport/>

⁹ <https://ec.europa.eu/eurostat/statistics-explained/pdfscache/1132.pdf>

air in 2017.¹⁰ The annual passenger increment on air traffic prior to the COVID-19 outbreak was expected to be of 3,5% each year.¹¹ Regarding freight transport, road transport accounts for more than half of the total freight transport activity within the European Union, with 75% over the total tkm transported. Road transport is followed by rail with 18% and maritime 6%.^{12 13 14}

The pandemic also compromised the maritime cargo transport. Being mainly a concern for the transportation of goods between Europe and China, the crisis had repercussion on the production in both regions. In particular, the ocean freight industry has responded to the lack of demand for goods from and to China by reducing the supply of shipping services. Europeans port are expected to be running at 20-30% of their full capacity in the coming months, thus reducing the demand for ocean liners with a capacity of ten thousand containers.

In the context of EU – China freight transport, long-distance trans-Eurasian rail lines appear to be not only mostly untouched by the crisis but also benefiting from it. Trans-Eurasian rail is experiencing a push as it proved to be eight times cheaper than air freight in normal circumstances however taking triple amount of time¹⁵. At the same time, while rail transport still remains two times more expensive than sea freight, its transit time is half the time needed for ocean freight to reach Europe from China.¹⁶ The crisis is leading to elevated air shipping prices and longer transit times in both air and ocean freight, thus increasing the competitiveness of rail transport. As a result of the lack of viable transport modes between EU and China because of the COVID-19 crisis, trans-Eurasian rail lines became a reliable choice and economical option for companies that need to receive and send goods.¹⁷

IMPACT ON ENVIRONMENT

The COVID-19 pandemic also has consequences for the environment: greenhouse gas emissions (GHG) are low, and air quality has gone up. This happened to coincide at a time in which the European policy towards clean transport failed to achieve a reduction of GHG emissions. Unlike other sectors such as agriculture or industry, GHG emissions from the transportation sector have increased dramatically since 1990.¹⁸

However, optimism on the effects of COVID-19 on the environment is misplaced. As UN Secretary-General Antonio Guterres highlighted, “We will not fight climate change with a virus”. In fact, the current drop in carbon emissions is expected to coincide purely with the virus outbreak. GHG emissions are expected to rise again once the pandemic has finished, paving the way for a rebound effect similar to what followed the 2008 financial crisis. In this instance, the crisis caused a 1% drop in CO₂ production, but emissions increased by 5% once the crisis passed. Therefore, it is expected that, once the virus disappears, those measures which have been put in place for its containment will be dismissed and with them the incidental benefits on the environment.

However, some new habits may have come to stay, even if on a voluntary basis. Companies which were skeptical about the introduction of teleworking will now understand the possibilities of this working mode, resulting in less need for commuting and less space needed to conduct business. As such, companies might be tempted to maintain the teleworking approach and save on rents and utilities. This could have an impact on GHG production, albeit a rather limited one. At the same time,

¹⁰ <https://ec.europa.eu/eurostat/statistics-explained/pdfscache/1132.pdf>

¹¹ <https://www.hindawi.com/journals/jat/2018/6205714/abs/>

¹² https://ec.europa.eu/eurostat/statistics-explained/index.php/Freight_transport_statistics_-_modal_split

¹³ <https://ec.europa.eu/eurostat/statistics-explained/pdfscache/1142.pdf>

¹⁴ https://ec.europa.eu/transport/facts-fundings/statistics/pocketbook-2019_en

¹⁵ <https://www.chinainportal.com/blog/how-long-does-it-take-to-ship-from-china/>

¹⁶ <https://www.dsv.com/downloads-and-services/white-papers/rail-freight-between-europe-and-china>

¹⁷ <https://www.forbes.com/sites/wadeshepard/2020/03/31/china-europe-rail-is-set-to-boom-as-covid-19-chokes-air-sea-and-road-transport/>

¹⁸ https://ec.europa.eu/clima/policies/transport_en

the rise of home delivery and e-Commerce will also have impacts on the environment, creating more GHG both as a result of a larger fleet of vehicles delivering goods to the end-user and the higher use of packages and waste.¹⁹ At the same time, it is not clear if the increase in eCommerce transport will be met by lower levels of private transportation. In fact, the eCommerce's role in GHG production largely depends on the customer behavior after purchasing online orders. Whether customers consume cheaper consumer goods at a higher rate when shopping online, or how would consumers use their time that was previously spent shopping retail, are factors that vary greatly but have high relevance in estimating the impact of eCommerce on the environment.

To avert the "return to normality" vis a vis GHG production once the threat of the virus has been eliminated, it will be necessary to introduce structural changes. It will be imperative to avoid the mistakes made after the 2008 financial crisis; any stimulus spending that might follow the COVID-19 outbreak cannot boost fossil fuel consumption. It will be necessary to match the need for governments to avert a deep recession and the needs for safeguarding the environment. One example for promoting a green recovery would be, for example, the introduction of a carbon tax. As the transport sector plays a fundamental role in GHG production, it is now time to acknowledge this fact and act accordingly. It will be vital to safeguard environmental protection and mobility necessity at the same time, actively promoting a shift from transport modes which are not environmentally sustainable anymore to transport modes which are environmentally friendly and can play a great role in tomorrow's mobility.

WORKING HYPOTHESES AND FORECASTS FOR RAILWAYS

PASSENGER TRANSPORT

As of today, the absence of vaccination or effective drug to fight the COVID-19 means that there is a broad scientific consensus that social distancing is the only form of prevention that can reduce the spread of the virus. Almost every country around the world pushes for adopting social distancing measures, as they proved to be effective in halting the pandemic. Focusing on Europe, as the EU Member States will gradually lose the containment measure and economic activities will start again, it will be essential to provide the possibility for adequate social distancing measures also in the transport sector. In the worst-case scenario, social distancing will become, at least until 2021, natural part of everyone's lives, and this must include travellers on any transport mode.

Similarly to the developments in China, South Korea and the US, there are attempts by EU governments of developing geotracking systems using Bluetooth perimeters and big data, capable of calculating the risk for a specific individual to have been in contact with someone carrying the virus. If concerns over privacy issue will be settled and the technical development will be over, such a tool may be massively effective in identifying new outbreaks of the virus and allow quarantine measures for suspected new cases. The extent on sustaining the effectiveness and capability of new technologies to safeguard public health will play a crucial role in determining which transport mode will be safer in the upcoming period.

Similarly, the transport sector may have to adapt to severe health controls before the passengers boarding. Body temperature controls or "COVID-19 passports" checks may be in place on every public transport and may be mandatory for travellers to enter the train/coach/aeroplane. Likewise, entrance restrictions may be introduced, similarly to the retail industry. It may also be necessary to

¹⁹ <https://venngage.com/blog/coronavirus-impact-on-environment-infographic/>

implement new guidelines for providing deep cleaning and sanitization of each transport mode as necessary.

In all these aspects, rail will have an advantage over road and air transportation. Because of the composition of passengers' wagons, the adaptation of the layout regarding passengers' seats will be fast and efficient. Rail will be able to provide safe, independent compartments in which a small number of passengers will be able to travel and apply social distance measures. Furthermore, by tracking passengers within the different compartments, rail will be able to provide data to detect which passengers could have been exposed to the virus during their journey. Lastly, rail will provide a cost-efficient transport mode in relation to the new requirements on health controls. It will be possible to implement security controls which will be smooth and fast, safeguarding both passengers and health operators prior to their access to the train station. It will be possible to install thermal cameras able to measure body temperature to several people at the same time. Furthermore, because of the characteristics of the passengers' wagons, it will also be possible to provide deep cleaning and sanitization of the wagon between each new journey.

URBAN MOBILITY

Looking at urban mobility, end-users will face a decision regarding which mode of transport to choose between private transport (i.e. cars, bicycles...) or public transportation. On one side, demand may push forward private mobility as a result of the fear of infection and interaction with other users. However, the use of private mobility as automobiles is not self-evident. The crisis hit automotive manufacturers worldwide hard, which have then been forced to shut down operations on the vast majority of their production plants. While it is still uncertain to which outcome the crisis will push the automotive industry, predictions are unlikely to expect car prices to remain stable to the pre-crisis level. In particular, the impact on the automotive sector is expected to foster new technologies and solutions like electric vehicles. In this context, some automotive companies already asked the European Commission to postpone CO₂ targets related to the production of hybrid and electric vehicles.²⁰ On the other hand, Member Countries as Italy are planning to increase the fiscal bonus to consumers willing to buy an electric car from 6.000 to 15.000€. ²¹ However, both solutions appear short-sighted.

In the context of an economic crisis with car prices higher than before the COVID-19 outbreak, focusing on vehicles production rather than environmental protection means to delay the effectiveness of environmental measures and lower the competitiveness of innovative solutions such as electric cars. In particular, if the EU were to postpone environmental measures to focus on protracting the production of an obsolete vehicles fleet which will have to be forcefully shelved in a relatively short period, this would not only undermine the industry competitiveness on the world markets but also undermine the EU credibility in the consumers. On the other side, the introduction of large investments from the Member States in pushing for an industry which is not able to compete yet with traditional combustion vehicles, both for range and availability of charging station, would have serious consequences. Firstly, it will create a dangerous division between segments of population. The highest end-price of an electric vehicle compared to cars with a combustion engine will remain a constant factor in the immediate aftermath of the crisis. This will be met by a lower purchasing power from the hardest-hit sections of the populations, and by an uneven distribution of charging stations across the country. The result will likely be a situation in which those benefiting from these incentives would also be those not in need of economic aid and closer to economic

²⁰ <https://energypost.eu/covid-19-and-the-eu-car-industry-any-support-should-lock-in-ev-targets/>

²¹ https://www.corriere.it/cronache/20_aprile_13/sergio-costa-ecobonus-90percento-colonnine-elettriche-cosi-parte-svolta-182061b0-7d5b-11ea-bfaa-e40a2751f63b.shtml

strongholds within the country. Lastly, such measures would drain important resources which could be poured in providing safe, affordable and environmentally friendly mobility as tram or metro. At the same time, the insurance sector has also suffered serious difficulties as a result of the COVID-19 crisis, making unclear whether consumers will see prices grow or less. However, despite an increase in insurance and car costs, regarding both newly purchased vehicles and spare parts for the older circulating fleet, the sector of private mobility - especially in the context of urban and commuter mobility - will likely increase. Fear of health risks and health controls will likely drive this trend, which will coincide with under usage of public transportation in these contexts.

In this context, those cities which will give priority to cars will face the possibility of seeing their mobility collapse, as most European pre-COVID-19 cities already suffer from their congested streets. Green private mobility as electric bicycles or electric scooters may play an important role in urban mobility, as the decision of New York regarding legalisation of e-bikes and scooters shows.²² However, several cities across Europe still lack adequate legislation on the regulation of electric vehicles as scooters and bicycles.²³ Furthermore, not only these mobility solutions are still relatively expensive and remain mostly private, but their capacity of replacing public mobility in a very short time is still unproved. Policymakers will have to decide whether to continue the current policies on restrictions regarding polluting vehicles or update the legislation vis a vis electric smart mobility. At the same time, metro will be able to provide deep interconnection with micromobility (lightweight devices operating at speeds typically below 25 km/h) services such as electric scooters and bicycles and will play a key role in the concept of Mobility as a Service, providing fast, affordable, reliable services on an already existing, integrated and working network.

It will be necessary to avoid the risk of underuse of public transportation to continue providing mobility services without the drawbacks of private cars usage. To avoid such a risk, it will be necessary to reduce capacity constraints the rail sector might face. The economics of rail supply will equally need to be kept into consideration, as those parameters important for end-users, as frequencies, performance and train length, will need to be re-evaluated. However, amongst the public transportation services, rail still has the advantage over road mobility. Metro will be able to provide adequate space for carrying out health controls operations if needed. However, it has to be reminded that such a process is both invasive and not desirable. It is strong belief of this proposal that railway transport needs to provide a seamless continuous experience without the physical and technological barrier that such a solution would promote. Especially in the context of urban mobility, ineffective and intrusive measures will reduce the advantages of rail pushing end-users back to individual mobility. Strong incentives will be necessary to limit the overestimation of COVID-19 in comparison with other risks and restore passengers' psychology vis a vis their general acceptance of risk to the pre-crisis level.

At the same time, a reduction in the capacity of trains might lead to an increase in private transport. It is therefore essential to improve the frequency and availability of trains, to avoid a dangerous shift of commuters to cars. In comparison with private vehicles, rail will be able to offer cleaner, safer and more punctual mobility services. In the context of cities which are increasingly facing problems caused by transport and traffic,²⁴ a sustained increment towards the usage of private cars needs to be avoided. If fears over the spread of COVID-19 will result in the prioritisation of private car over public transport, European cities would experience a dangerous shift. If this modal shift towards the private car crystallizes the collapse of the urban transport system in the major European cities would

²² <https://www.theverge.com/2020/4/2/21204232/new-york-legalizes-electric-bikes-scooters>

²³ <https://www.bbc.com/news/world-europe-49248614>

²⁴ https://ec.europa.eu/transport/themes/urban/urban_mobility_en

be inevitable, and/or the need of massive subsidisation will emerge. This would have a number of negatives consequences, such as a less safe environment - both for road users and CO₂ production - productivity and economic loss due to increase time in traffic congestions and worsening of quality of life for the inhabitants. Rail will be able to tackle these challenges and provide a better service than conventional private mobility.

SUBURBAN MOBILITY

Following the footsteps of the urban mobility scenario, end users might prefer private mobility as a result of the fear of infection and interaction with other users. However, private mobility will also be limited by the higher price in the automotive and insurance sectors. At the same time, economic incentives for the purchase of electric vehicles will have less effects amongst the population living in suburbs or commuter towns than amongst city population. On one side, the low capillarity of charging station on the territory does not allow a comfortable shift from traditional to electric vehicles. On the other side, the current regulation in different EU Member States does not provide economic sanctions towards polluting automobiles out of the main city areas as much as within the city limits. As such, while the population living within city limits is pushed toward the choice of purchasing an electric vehicle with economic incentives and away from older technologies as diesel vehicles with sanctions, the population living outside of the city limits only have limited incentives and need to face infrastructure deficit. At the same time, in the context of suburban mobility, the choices of private mobility such as electric bicycles or scooters, will be extremely limited due to the nature of commuting distances. Rail will still play a major role in passengers' mobility. Therefore, similarly to the urban scenario, important parameters such as frequencies, performance and train length, will need to be re-evaluated according to the new context.

If necessary, under extreme circumstances, public mobility will be able to offer enough space to carry out health control operations. However, these operations will need to be as minimal as possible as it is crucial for railway transport to continue providing a seamless experience with deep interconnection with micromobility services such as electric scooters and bicycles. Rail will have advantages in comparison with private vehicles, as it will be able to offer cleaner, safer and more punctual mobility services.

LEISURE AND WORK-RELATED LONG-DISTANCE TRAVELS

The words from the EU Commission President Von der Leyen, which recommended "waiting before making plans" on holiday reservations are indicative of the state of the touristic sector in Europe. Long-distance travel is expected to be taboo until 2021 at least, but the development of the situation might postpone the date further on. The long-term effects of the COVID-19 crisis on tourism are still unclear, as it heavily depends on the economic measures the Member States and the European Council will implement to safeguards business from the economic crisis. So far, the best-case scenario is characterized by a severe reduction of long-distance travel for leisure and short-term tourism. This decline will have impacts on each transport mode. International journeys are expected to not recover for a while. While the impacts on long national journeys will be less drastic, they will still suffer a severe setback.

The air sector will likely be the heaviest affected transport sector, as not only it will be extremely demanding and expensive for air companies to provide effective measures to ensure social distance and health controls but it will also be challenging to maintain crew and operators' safety and provide deep cleaning and sanitization to the aircraft. The economic model of airlines will have to adapt to the new health requirement. The number of passengers allowed on board is expected to be much

lower than the pre-crisis level, to facilitate social distancing measures. As such, the aggressive yield management at the base of airlines business operation will likely be reduced, raising the price of airplanes tickets consistently. Rail might be sharing the reduced capacity with airlines for a short period, but its business model would allow an easier adaptation than the business model upon which airlines are working. At the same time, it is expected that the orders from airlines for new aircrafts plummet. Therefore, the production of airplanes and the R&D of new models is likely to drop steadily. As both Boeing and Airbus, the two main aircraft manufacturers in the world, will probably leave the crisis in need of state aids, it will be necessary for the two companies to reduce employment and restructure their supply chains.²⁵ The crisis will heavily influence the air transport sector for years to come, with unclear effects on airline companies and aircraft manufacturers alike.

Rail will be able to provide better service and health standards as identified earlier, providing a safe journey in which apply social distance measures, contributing to data collection to help detect and avoid eventual new outbreaks, allowing smooth fast and secure health controls prior to the departure respecting both passengers and health operators. Furthermore, in the eventuality that the vaccine to COVID-19 will need to be introduced *en masse* into the European population, train station could play an important role in safeguarding public health. Amongst the available solutions, it could be possible to introduce "COVID-19 vaccination centres" in major train station in order to provide wide accessibility to the vaccine without creating capacity problems to health centres and hospitals. However, it will be necessary to distinguish two different approaches of passengers to long-distance journeys. On one side, travels of business nature could be, for a very short time, compatible with constraints and invasive health controls. On the other side, leisure and tourism journeys are extremely unlikely to be compatible with such constraining conditions, and the large majority of travelers would renounce undertaking a journey under the pending threats to be blocked or quarantined as a consequence of invasive medical controls, no matter how physical or "intelligent" these controls would be.

In this context of limited controls which needs to be introduce in the short term, long distances will be covered by night-train services characterised by individual and familiar compartments. The design and subsequent adoption of a "COVID-19 intelligent" sleeping car will provide smooth and pleasant journey while complying to possible health protection regulations. Furthermore, this measure could be implemented with a limited cost, as the introduction of such a wagon would rely on relatively inexpensive or quick rebuilding of already existing wagons. It will be possible for families and groups to travel seamless without renouncing to long-distance journeys and remaining in accordance with health regulations. Such an arrangement will be extremely unlikely in air transport, due to the higher costs of adaptation of the aircrafts which will greatly affect the ticket price for the end-user. Rail will be able to compete with air transport on long distances in several areas: prices will be lower CO₂ emissions will be noticeably inferior and at the same time compliance with health controls higher. On the same line, night train will eradicate the need for overnight stay, thus diminishing the need for social contact. To enhance the effectiveness of these measures, it will be necessary to identify those routes where rail competitiveness over air traffic can be highest. This step will allow an effective substitution of air transportation by long-distance trains.

HIGHER CONTROLLING OF INDIVIDUUM MOBILITY PATTERNS

In each scenario involving passengers, transport modes might have to work together with new technologies to contain the spread of the virus. Amongst them, there could be geotracking systems capable of calculating the risk for a specific individual to have been in contact with someone

²⁵ <https://www.ispionline.it/it/pubblicazione/aviazione-giganti-crisi-di-liquidita-25796>

carrying the virus. Other technologies will require thermal cameras to measure health parameters such as body temperature with thermal cameras prior to the passenger entrance, always respecting the privacy. Computer vision technology could be used to detect when social distancing norms are breached by transit workers or passengers at stations and in vehicles. Air filters and fans could be also employed by the transport sector to ensure air circulation to flow vertically from ceiling to floor throughout the compartment rather than horizontally from one passenger to others, thus minimising the possibility of spreading the virus within the transport carrier. Transportation will be required to support these systems. However, the existence of emergency health measures will also play an important part in shifting the perception of passengers' vis a vis railway and push them instead toward the choice of personal mobility. While this proposal firmly advises against the unnecessary deployment of invasive system to over-protect passengers' health in the entire public transport sector, it also underlines how rail has an advantage over other public transport modes, and especially airlines, if such systems are implemented.

Firstly, rail can accommodate technical equipment with limited constraint due to the size or energy consumption of the vehicle, as it would be the case for coaches or airplanes.

Secondly, rail can employ an external infrastructure such as train or metro station more sophisticated than buses but in need of less human interaction for its proper functioning than airports. The advantage of this infrastructure relies on the possibility of its employment for carrying out security measures to give access to the rail mobility to those passengers which do not present symptoms of COVID-19. At the same time, these measures can be carried out with complete respect of the healthcare professionals' wellbeing and the passengers' privacy.

Thirdly, dedicated innovative tools for the prevention, the recovery and the containment processes must be developed to control the virus during mobility activities. Passengers and rail staff can then be individually protected by dedicated supports or rail car or train cabin can be equipped by automatic disinfection systems. Innovation for safety barrier development is a way of research for rail transport. For instance, personal protective equipment like mask, full wetsuit, helmet, gloves can become intelligent by integrating dedicated sensors and actuators to support the control of spread of the virus. These new advanced technologies may supervise the minimum separation distance between people or prepare the passengers flow on platforms. Another way to take advantages of innovation for humans is the development of intelligent systems for the automatic decontamination of seats, hand support, grab bars or rail cars. This can be done by friendly and educational robots. The actions of new automated supports to be introduced on rail systems have to be done by respecting the privacy data of passengers and staff.

FREIGHT AND LOGISTICS

In March 2020, 75% of companies globally reported interruptions in their supply chain due to transport restrictions, 46% of companies of international logistics have experienced significant delays in the shipment from Chinese ports. Furthermore, significant delays have been experienced in the shipments to China for 86% of the companies, 74% in Europe, and 44% in North America.²⁶ The first disruption concerned the Chinese lockdown, but now the problem has moved to Europe. The crisis is causing effects on the entire logistics chain of shipments with heavy disruptions of entire supply chains. The picture is expected to be more fragile in light of the upcoming global recession, which will have consequences on advanced and emerging economies alike. As a result, global value chains are expected to be restructured, following a trend of regionalization of supplies. As such, WTO

²⁶ <https://www.ispionline.it/it/pubblicazione/shipping-corsa-ai-ripari-la-tempesta-perfetta-25802>

estimates that in 2020 world trade will decrease by up to 32%, thus producing profound effects on international logistics companies.

As economic activities will be likely to remain locked down or operating under difficult conditions in the near future, higher prices in production are expected. As the entire production chain will suffer from either lower workforce or higher prices compared to the pre-crisis level, production is still likely to remain lower and/or more expensive. Higher prices will also be a result of the challenges the transport sector will encounter. Road transport, in particular, may suffer the consequences of controls at the borders, forced quarantine for drivers and higher insurance prices. Traffic jams of up to 60 km length on the German-Polish border or 90 km on the Brenner pass illustrate the vulnerability of road transport in times of tightened border controls in the Schengen area.

Sea transport is also likely to encounter challenges, such as the personnel restrictions or the limited number of containers to be transported. This last aspect, in particular, plays a key role in sea transport competitiveness as the size of vessels must be adapted to the transport demand to be competitive. This may force some shippers to operate with smaller vessels such as Panama and Post-Panamax and berth new high-capacity New Panamax and Ultra Large Container Vessel. This transport mode is also likely to suffer consequences on higher insurance prices. Prolonged overcapacity at a time of limited demand may be source of vulnerability for individual logistics and container transport company. At the same time, as the 2016 bankruptcy of Hanjin showed, these factors can be liability for the entire maritime transport system. However, sea transport might take advantage of the crisis to introduce intelligent systems as AI, robotics, automatic handling and navigation.²⁷

Rail freight will also face significant challenges, particularly related to the slowdown in industrial output. Measures will have to be put in place to prevent disappearance of operators and capacity possibly through State support in the short-term. The freight sector proved to be resilient to the crisis and operators shifted capacity from seaports traffic to intra-European transport.²⁸ The European Commission decided to provide Green Lanes at border-crossings to expedite the transportation of goods within a short timeframe,²⁹ albeit further efforts are required in addressing train drivers as strategic workforce thus allowing smooth border-crossing operations.³⁰ Rail freight proved to be resilient during this crisis, and it proved to be able to play a significant role also in sectors where its presence is not yet consolidated. Rail has rapidly adapted to transport types of goods which have not typically been part of their core business. As an example, the rail North-South Rail corridor has been essential in allowing rail to become a fast delivery mode of break bulk products. Rail has been able to transport essential food as pasta from Italy to Germany on short notice, ensuring that supply chains in Europe are up and running. In this instance, rail gave the manufacturer the reassurance that its products could be delivered. Rail also provided the retailer with the ability to respond flexibly to supply bottlenecks and allowing consumers to maintain their shopping habits

In this context, European logistics should focus on the “recovery” phase. Boosting internal consumption will be a high priority, together with export support and new investments.

Investments on infrastructure are considered as a countercyclical tool in a time when consumption, investments and trade are restrained by the economic slowdown. Infrastructure development is a pivotal component of future development, as it increases potential output, productivity and competitiveness. Investments will have to be implemented focusing on transformation and technological modernization in light of sustainability needs and international competitiveness.

²⁷ <https://www.ispionline.it/it/pubblicazione/shipping-corsacai-ripari-la-tempesta-perfetta-25802>

²⁸ <http://www.cer.be/media/press-releases/railway-operations-during-covid-19>

²⁹ <http://erfarail.eu/news/transport-associations-welcome-agreement-of-eu-transport-ministers-and-european-commission-on-freight>

³⁰ <http://www.cer.be/media/press-releases/railway-operations-during-covid-19>

Infrastructures play a fundamental role in this scenario. Both in the Member States and at the EU level, it will be necessary to implement a fast and functional regulatory framework able to provide an immediate start for projects. It is of paramount importance to push forward digital and physical infrastructures to support the mobility of citizens and goods, both at national and European level, with a focus on efficiency and respect for the environment.

As the TEN-T network has yet to be completed, it classifies as a precious set of investments ready for implementation. The current crisis has to be a call for action in enhancing the audacity of the project and push forward aspects related to environmental respect and intelligent systems. It is necessary to seek for a modern, efficient and sustainable infrastructure system as it is an essential factor for improving European competitiveness, efficiency and quality of life.³¹ Likewise, every step towards a coherent and interoperable TEN-T network improves the resilience of Europe not only against pandemics, but also against every other regional, national or global crisis.

As such, it will be necessary to place rail at the centre of the reconstruction phase and provide adequate funding for innovation activities. Innovation needs to be the key driver behind every step throughout rail development and promoted throughout the European research program. The new funding program Horizon Europe has to reflect this vision and therefore address the problem of consistent inadequacy of funding program to develop a smart, efficient, innovative and reliable rail sector.

WAY FORWARD, THE 5 "R"

Since the outbreak of the COVID-19 crisis in Europe, the transport sector has suffered the adoption of unprecedented measures. Travel and manufacturing have been restricted significantly to avoid the spread of the virus. Diminished production and disrupted cross-border supply chains influenced rail operators heavily. However, the Union-wide lockdown proved the critical role the transport and logistics sectors continue to play in delivering essential products, and in particular the resilience and competitiveness of the freight sector.

When re-thinking the near future of rail, it will be necessary to provide safe, independent compartments in which a small number of passengers will be able to travel and apply social distance measures. Because of the composition of passengers' wagons, the adaptation of the layout regarding passengers' seats will be fast and efficient. Rail will also provide a cost-efficient transport mode in relation to the new requirements on health controls, as it will be possible to implement security controls which will be smooth and fast, safeguarding both passengers and health operators prior their access to the train station. Special focus will be placed on the new requirements on deep cleaning and sanitization of the wagon between each new journey.

However, simply adapting the European railway sector to this new challenge will be limiting and self-harmful. It will be necessary to reconsider the role of rail in Europeans' lives, keeping the terms sustainability and competitiveness at the centre of tomorrow's vision of Europe.

It becomes recommendable for the European rail sector to undergo the following steps:

- Resilience
- Return
- Reimagination
- Reform

³¹ <https://www.ispionline.it/it/pubblicazione/infrastrutture-un-recovery-plan-post-pandemia-25793>

- Research

RESILIENCE

The European rail industry will need in the immediate term to address cash management challenges, SMEs require support from EU institutions to cope with the shutdowns and the economic effects which are expected after the crisis. This requires the development of new abilities for rail transport systems as plasticity and learning to adapt as quick as possible their mobility missions accordingly. Measures are to be introduced, which make the European rail industry more robust against pandemics and similar threats. In the long term a higher grade of automation in operations will provide a different, but hopefully less vulnerable system, as will measures of predictive maintenance with respect to a resilient infrastructure. Regarding a strong financial resilience, the accelerated introduction of electronic ticketing systems, addressing cash management challenges and information campaigns will provide valuable impacts.

Furthermore, the current period of reduced timetables should be exploited as a chance of focusing on maintenance and renewal of the current fleet, as it is a major challenge on congested networks.

RETURN

The European Union institutions will need to create a detailed plan to return the business back to scale quickly, as the virus evolves and knock-on effects become clearer. Indicators or indexes have to be developed in order to control the evolution of the instability recovery due to such a crisis, to determine the short-term, medium term and long-term prevention, recovery and containment actions, to assess their impacts and to redefine them if necessary.

REIMAGINATION

Both the EU institutions and the rail industry will have to re-imagine the “new normal”, to adapt the rail sector to the aftermath of the crisis, provide service and maintain competitiveness. Considering a future perspective, it will be necessary to immediately look ahead and provide much-needed funding for research and development activities. The rail industry needs to be at the centre of Europeans' mobility, and this can be achieved only through a higher availability of funds. Universities, research institutes and companies need to be able to expand their work, produce more scientific innovation, and reaffirm Europe's role as the world leader in transport. Dwindling public funding must not hinder rail development across the EU, especially at the time of unprecedented possibilities for the railway sector. Given its advantages over other transport modes in light of the current crisis, the rail sector finally deserves to be at the same level of funding for R&D activities with air and car manufacturers.³² It will also be necessary for transport policy makers to focus on the policy measures that should be considered both during the current crisis and during the transition to the “new normal”. It will be necessary to align policies that promote economic growth and transport policies. It will be necessary to promote economic recovery while also pushing for changes in behaviour such as promotion of walking and cycling. In this context, public transportation and especially rail transport can play a fundamental role.

REFORM

³² Airbus R&D: <https://www.statista.com/statistics/226726/rundd-expenditure-of-airbus/>

Car R&D: <https://www.acea.be/press-releases/article/54-billion-spent-on-rd-by-eu-auto-sector-per-year-latest-data-show>

Rail R&D: <https://www.uiprail.org/index.php/dossier-menu/policy/eu-financing>

The European Commission, in its New Industrial Strategy for Europe, highlighted the role of the rail sector before the COVID-19 crisis and expressed the intention of “maintaining the European industry's global competitiveness and a level playing field, at home and globally”. This is not enough anymore. At the same time, the Commission's Green Deal highlights rail as a “special focus” with the objective to “ensure that EU mobility industries maintain their global technological leadership”. Similarly, this is not enough anymore. The European position towards rail dates back to before the COVID-19 crisis, and as such, it is not ready to cope with its consequences.

RESEARCH

The additional challenges faced by the European rail system during and after the pandemic will only be overcome with the support of a strong Europe-wide rail research program. Key elements of the rail research landscape are the European universities and research institutions. Cooperation between universities and research centres needs to be reinforced not only to provide innovative solutions in rail technologies, but to improve the competitiveness of European research, align needs of the rail industry and methods of the academia and form the new generations of researchers with a comprehensive approach to the rail sector.

To this end, it will be necessary to allow European universities and research institutions to be heard in rail-related EU decisions. The voice of universities and research centres needs to be heard in the European decision-making process, to ensure the strategic vision will be shared amongst all the key actors in the European rail sector and its effectiveness will be as significant as possible. This more substantial presence of universities and research institutions into the decision-making process has to be met by higher availability of funds. Only through adequate economic involvement, it will be possible for universities and research centres to provide innovation, research and development activities which will have real impacts in rail development. At the same time, funds need to be equitable. Research and innovation activities have to be shared according to the vision and direction of the Europe-wide rail research program. It is necessary to provide a strong political direction shared by every actor in the rail sector, including universities and research centres. Large enterprises cannot steer or the vision of the future European rail sector alone, university and research centres have to be involved.

Furthermore, the COVID-19 pandemic also raises awareness on the necessity of additional funds in several key areas:

Additional research efforts are necessary on the digitalisation and automation of vital processes dependent on manual operations (i.e. use of IoT and robotics for track and rolling stock monitoring and maintenance, ATO and automated driving, integration of A.I. and Big Data). In strict connection with the need for digitalisation and automation, this crisis highlights the need for research on developing pandemic or disaster related training schemes for rail workforce.

At the same time, additional funding has to cover the necessity of detailed multi-dimensional analysis of urban mobility patterns after the COVID-19 pandemic. Furthermore, there is need for research in terms of operational supply side and demand side (user perceptions) related to the COVID-19. It will be necessary to address the way in which this crisis will affect private rail firms running services.

Especially relevant for rail freight is the need of additional research efforts for producing studies on reducing operational costs via new transport policies and legal actions.

Further research efforts will be necessary to learn valuable lessons from errors in the COVID-19 pandemic management. Changes in actions requires immediate answers, and interdisciplinary

research actions can provide some guidelines for railway transport. Logistic, contribution to dismiss the propagation and disinfection are some of the lines of interdisciplinary cooperation between research centres and universities based on the tools available over the concepts of digitization; but also design and manufacturing resources such as 3D printing and generative design that provide experimentally based solutions compatible with railway technology schemes.

The traceability of logistics using learning and predictive models capable of offering prognosis on sources of propagation in transport joined to the optimization of the resources of the railway community. Decision-making in access to the railway services, the distribution of the users in trains and stations, the optimization of work condition and the operation management are the main overview of request for research, but also in making the resources of the railway community available to the public health demands.

Likewise, the pandemic exposes the urgency in investing in interdisciplinary research on development and use of self-cleaning materials on trains (such as photocatalytic coatings used by Japan on train and station interiors, or recent applications on e-scooters). Research into materials that minimize the capacity for viral infection on surfaces that can be touched by transport users (doors, seats, ticketing machines, etc.) and the purification of air through suitable air-conditioning methods and air filter design in indoor closed areas and vehicles in sanitation and disinfection concepts compatible with railway regulations and public health criteria are other line of action towards preventing and stopping the spread of disease.

RAIL AS BACKBONE OF EUROPEAN SUSTAINABLE MOBILITY

Despite the burden the outbreak placed on European citizens' shoulders, the current situation can be an opportunity. It is not sufficient anymore to "maintain" the rail competitiveness. It is finally necessary to increase it, placing rail as the real backbone of Europeans' mobility. Not only rail proved to be less prone to disruptions than air and road transportation, but it can provide an effective role in ensuring mobility and fighting the virus spread. At the same time, it is not enough to provide "special focus" to rail in green mobility anymore. It is necessary to take notice of the short-sightedness of sustaining carbon fossil fuels at a time in which green transition is cheaper and more effective than never before. In the context of a steadily growing transport sector in terms of GHG emission, it is now time for a concrete modal shift from road and air to rail, the most environmentally friendly mode of transport. As growth is expected to resume, it will be necessary not to delay research and investments to improve the role of rail in public transportation. To guarantee that the rail sector will lead the new mobility, it will be necessary instead to step up the efforts and imprint a strong direction towards a sustainable future. Taking the necessary steps forward at this historical time will guarantee immediate connectivity for European citizens and goods, but equally importantly it will guarantee a truly sustainable future for Europe and the chance not to miss the only opportunity arising from the toughest challenge the EU ever faced.