

COVID-19 and its impact on *Railway* sector in Asia and the Pacific

Transport and trade connectivity
in the age of pandemics

UN solutions for contactless, seamless
and collaborative transport and trade

Policy brief
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Sustainable Railway Connectivity along the Trans-Asian Railway Network during and in the aftermath of COVID-19: Opportunities for building back better¹

1. This policy note has been prepared by Sandeep Raj Jain from Transport Division ESCAP under the United Nations Development account project- "Trade and transport connectivity in the times of Pandemics" with inputs from Ekaterina Kozyreva, Consultant. The views expressed herein are of the authors and do not necessarily reflect the views of the United Nations.

Key Messages

1. During the COVID 19 pandemic international railway transport proved its reliability to maintain the sustainable connectivity along the Trans-Asian Railway network- as the rail freight flows avoided major restrictions. However, as the pandemic situation is still evolving in each country there is going to be uncertainty over short term on easing containment measures- with consequent adverse effects on railway freight transport
2. In medium term the key challenges to rail freight flows would come from a prolonged pandemic with significantly asynchronous trends in spread and recovery that could worsen the economic crisis, further decreasing demand and the short-term disruptions to regional and global supply chains could be permanently impacted resulting in suspension of some rail freight services
3. Railways of the region must turn this crisis and period of uncertainty into an opportunity by undertaking measures to increase the comparative advantages of railway transport enhancing sustainability of transport networks
4. Digitalizing and decarbonizing railways, harmonizing operational requirements and regulatory formalities, integrating with other modes of transport, bundling of freight and partnering with other stakeholders are key areas of opportunities for railways post pandemic to enhance their competitiveness
5. Pandemic has given further momentum to digitalization of railway transport even in countries with relatively low level of digital services. It has led to innovative solutions such as establishment of green lanes for medicine products. The railways of the region now need to build on these initiatives incorporating them into national railway strategies

6. ESCAP would continue to play key role in supporting member railways in fostering railway transport in the region primarily through the Working Group established under the intergovernmental agreement on Trans-Asian Railway network that is a pre-eminent regional platform for railways of the region to address challenges and harness opportunities for enhancing sustainable railway connectivity in the times of pandemic and beyond

7. Over long run the geography of rail freight flows in ESCAP region and beyond, as well as the market in general might undergo substantive changes post-pandemic crisis due to changes in supply chains and possible relocation of production. Therefore, railways of the region need to revisit national railway plans/strategies/investments/business models incorporating likely impacts of the pandemic and prepare themselves better to deal with eventualities



I. Background

Transport and economic development are inextricably linked. Transport provides access to opportunities and as economies grow so do their needs for mobility. The ITF Transport Outlook 2019 indicates that global passenger and freight transport would triple by 2050 from 2015 levels with a significant part of this growth taking place in Asia. Given the magnitude of projected increase in demand for transport the supply for transport infrastructure and services would need to be scaled up. However, growth of transport since last many decades has come with many negative externalities that have now taken unsustainable proportions. Therefore, the growing demand for transport needs to be met sustainably meaning apart from others, increasing the use of comparatively more sustainable modes of transport such railways.

To develop a regional railway network to support growing needs of intra and interregional trade ESCAP member countries exerted efforts for many years that led to formalizing the Trans-Asian Railway Network through an intergovernmental agreement in 2006. The Trans-Asian Railway network currently comprises nearly 118,000 km of railway lines in 28 countries and its development has been incorporated into national plans or strategies of several countries. The Agreement entered into force in 2009 and now has 20 contracting parties. The Trans-Asian Railway network plays a pivotal role in fostering the coordinated development of a regional rail network. Since the entry into force of the agreement in 2009, incidentally there has been near exponential rise in China-Europe freight trains that continue to rise year on year.

However, the COVID-19 pandemic served a big blow to transport demand globally. Within weeks all modes of transport were deeply impacted due to containment measures instituted by the countries as well as interrupted production and wider economic activities. Despite this international freight trains on China-Europe route demonstrated considerable resilience showing a growing trend and maintaining essential supply chains those related to food supplies and medical equipment.

The freight transport between Asia and Europe is mostly dominated by maritime transport carrying bulk and non-time sensitive containerized cargo while air transport carrying time sensitive cargo. Therefore, railway freight had to struggle to create its niche. Over last decade, however, it has been proven that rail can also be a competing mode in transporting goods across two continents. Operation of regular freight train services and opening of new routes clearly points to emerging trend that has been intensified by the pandemic. Given that rail is energy efficient and environmentally friendly, the crisis should be used as an opportunity, to further deepen this trend and boost international railway transport by addressing the outstanding challenges paving way for more sustainability on transport networks.

In this background the current policy brief explicates on the challenges and opportunities for international railway transport along the Trans-Asian Railway network. Following this, Section II briefly indicates the challenges to connectivity along the Trans-Asian Railway network. Section III provides an overview of the rail connectivity during the pandemic; it also highlights various initiatives of railways of the region to deal with the crisis as well as likely scenario for international railway transport post pandemic for medium to long term. Section IV identifies opportunities and ways to harness them for railways of the region to maintain and deepen sustainable railway connectivity in the aftermath of COVID-19 crisis. Section V elucidates briefly on the value that ESCAP brings to foster railway transport in the region. Finally, the brief concludes by underscoring the key opportunities for rail development during and in the aftermath of the Pandemic, created by the global digitalization trends.

The policy brief has been prepared under the United Nations Development Account project “Transport and trade connectivity in the age of pandemics: Contactless, seamless and collaborative solutions” that responds to a call to action, for the immediate health response required to suppress transmission of the virus, to end the pandemic; and to tackle the many social and economic dimensions of this crisis indicated in the United Nations SG’s report on “Shared responsibility, global solidarity: Responding to the socio-economic impacts of COVID-19” published in March 2020.

II. Challenges to transport connectivity along the Trans-Asian Railway Network

Challenges to transport connectivity along the Trans-Asian Railway Network can be understood mainly in two dimensions, the physical connectivity and the operational connectivity. The Trans-Asian Railway network consists of nearly 118,000 km of railway lines. Around 12,400 km of these railway lines are still to be constructed. These missing links, that are sum of the line sections declared to be part of the network, are obvious challenge to connectivity over the network. The member countries where these lines fall have been making efforts to construct these links however the gaps in required investment are huge. Rough estimates suggest an investment of around USD 75 billion to complete missing links along the network.

In addition to missing links the Trans-Asian Railway network has break of gauge challenge. There are five different gauges with three of them 1520 mm, 1435 mm, and 1676 mm being predominant. The break of gauge prevents seamless connectivity along the network; however, the railways of the region have been using practical ways to overcome the situation. Most common solutions that are working well include bogie changing and transshipment. The break of gauge is not as serious a challenge to seamless connectivity as it appears as trains anyway have to stop at the border crossings to do various regulatory formalities and if the break of gauge can be addressed in parallel then the delays can be kept to minimum.

The wider challenge to railway connectivity stems from operational and regulatory divergence among countries for international railway transport. This include lack of harmonization in formalities of border agencies, particularly customs as well operational requirements of railways. Recognizing these challenges in 2015, the ESCAP members adopted resolution 71/7 on Regional Cooperation Framework for Facilitation of International Railway Transport that identified four basic issues and eleven areas of cooperation for facilitation international railway transport. Furthermore, in 2017, at the Fifth Working Group Meeting of the Trans-Asian Railway network, it was recognized that the operational readiness of the Network requires

concurrent facilitation measures, such as harmonized customs formalities and efficient electronic information exchange among the stakeholders. Since then these issues have got heightened attention from the railways of the region.

Given the rising freight trains from China to Europe, the railways of the region have been engaged to address these issues at various fora's and in midst of all this the pandemic struck that has severely disrupted the regional and global supply chains. It is therefore important to take stock of the impact of pandemic on railway connectivity along the Trans-Asian Railway network to map the way forward.

III. Connectivity along the Trans-Asian Railway network during the COVID-19 pandemic

The transport connectivity along the network was affected due to closure of borders by the countries and other restrictions linked to the containment measures. The impact on connectivity along the network during the pandemic has been considered by a topological connectivity index. The index is used to evaluate the network connectivity linked only to border closures and not to rail network performance (speed, traffic carried etc. – these factors are considered as unchangeable). Most of the border crossings remained opened for freight traffic, while considerable of them were closed to passenger transport. It is reflected in the value of index which was 0.62 considering the closure for passenger transport and 0.85 for freight transport indicating deeper adverse impact rail connectivity for the passenger transport. The methodology for calculating index as well as the border crossing considered are provide in the annex to this Note.

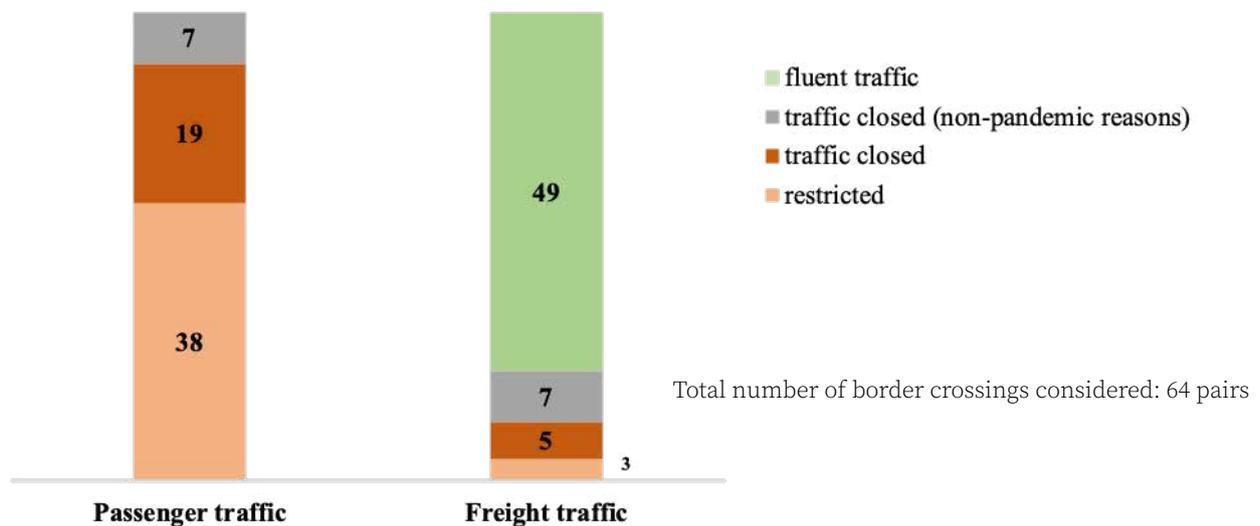
A. Passenger operations

As of September 2020, more than 50 per cent of the railway border crossings operate with severe restrictions and others are closed for any passage. The set of restrictive measures vary from country to country such as: temporal restriction for entry except for certain citizens (members of official delegations and diplomatic missions, family members of citizens, employees at transportation) and mandatory health tests for those who enter. At some border crossings like Singapore – Malaysia measures are moderate and additionally permit entry with work permission with a mandatory 14-days staying home.

Passenger traffic is restricted at borders of the countries in Central Asia. Some borders at Caucasus region are closed due to non-pandemic reasons. As can be seen in Fig. 2 - Connectivity index for rail passenger transport is the lowest due to high restrictions at many border crossings: the connectivity α index equals 0.66 with COVID-19 measures, which is about a 30 per cent less compared to non-pandemic situation.

In addition, currently there is no border crossing with fluent passenger traffic. Not only border crossing is restricted, but also international passenger train services are almost fully suspended. As of September 2020, most closed areas are Central Asia (with almost all border crossings of Turkmenistan) being closed, South Asia (India and neighboring countries), Eastern Asia (Mongolia and Democratic People’s Republic of Korea). Other countries have also imposed serious restrictions and have no operational international train services.

Figure 1. Status of border crossings in ESCAP member countries during the Pandemic²



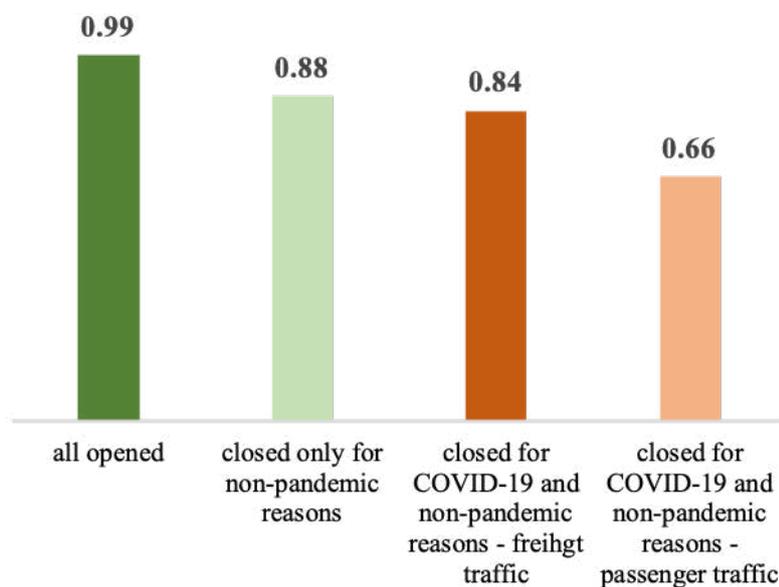
A recent study done by ESCAP on efficient operations of international passenger trains along Trans-Asian Railway Network has indicated enormous untapped potential for such trains. To harness this potential, it recommended that the railways of the region to further harmonize border crossing issues for passengers, streamline facilities at railway stations and encourage extensive use of new technologies to enrich passenger experience and in undertaking regulatory controls. Though the pandemic has dealt a blow to the nascent market of international rail passenger transport operations in ESCAP region, the railways can use this time to strengthen their

2. As of September 15, 2020

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Figure 2. Topological connectivity index of Trans-Asian Railway Network³



B. Freight connectivity

Freight traffic situation is fluent at 49 pairs of border crossings out of 64, according to available data. Some countries have established green lanes to ensure faster clearance of food, relief and essential supplies. Extra priority is provided for processing of any goods related to COVID-19 pandemic (like medical supplies). At the same time, attendants are subject to health check at many borders. Transit is mostly fluent without additional checks but with a health check of attendants. In recent months, the situation changed at Islamic Republic of Iran’s border crossings

3. As of September 15, 2020. Only full closure is considered for calculation of index.

with Turkey, Pakistan, Turkmenistan where borders were reopened on mutual agreement. The highest number of freight traffic restrictions geographically have been observed in Eastern Asia. According to the connectivity index, freight traffic along the Trans-Asian railway network operated smoothly despite some restrictions at North-South corridor.

The loosening of restrictive measures on freight traffic since May 2020 increased the connectivity index to 0.84 for rail freight in comparison to 0.79 in May 2020- its value before COVID-19 was 0.88. Still it should be noted that during the pandemic there were no major changes in rail freight connectivity, most of the border crossings being fluent for cargo transportation with some minor restrictions or procedural requirements for sanitation of rolling stock.

To reduce the paper from railway transport, many countries automated and digitalize the operations to cope with the pandemic risks

Even though rail freight transportation is generally exempted from border crossing restrictions, there are other types of constraints that affect operational connectivity and increase transport time such as imposing special procedures for rail staff. For example, all trains arriving to Turkmenistan are subject to disinfection⁴.

An important constraint for seamless rail freight operations is existence of paper-based documents which is still being used in most countries in the region. Railway staff (locomotives, stations, marshalling yards) of one country is obliged to pass required papers to the railway staff of other side, as well as to border authorities. This requires physical interaction imposing additional health checks and special procedures for the papers themselves as in case of China – Viet Nam where all paper documents are being subject to disinfection. To reduce the paper from railway transport, many countries automated and digitalize the operations to cope with the pandemic risks.

4. <https://wiki.unece.org/download/attachments/101548532/405%20-%2010042020%20-%20Geneva%20-%20UNECE%20-%20cargo%20procedures.pdf?version=1&modificationDate=1586847133274&api=v2>

C. Initiatives by railways of region during COVID-19

In response to COVID-19 outbreak and its impact on connectivity along Trans-Asian Railway Network many initiatives to facilitate remote services, electronic linkages between customs and railways have been implemented or in process of implementation in different countries, especially in transit ones. Selected measures taken by railways of the region are indicated in the Table 1 below.

More comprehensive picture of special measures taken by different countries as a part of policy response to pandemic in ESCAP region can be found in the note on: "Policy responses to COVID-19: Transport connectivity in Asia and Pacific"⁵. However, with respect to railways following trends are apparent.

- Most national railway strategies have yet to consider the full impact of COVID-19 pandemic in medium and long term
- There is no dedicated funded support programme for railways at international level yet⁶
- Railways proved to be reliable transport means to maintain the sustainable connectivity along the Trans-Asian Railway network- as the rail freight flows avoided major restrictions
- Pandemic helped in promoting faster solutions and special regulations (like establishment of green lanes for medicine products)
- Pandemic gave further momentum to digitalization of railway transport even in countries with relatively low level of digital services
- New solutions for customers and services, primarily digital, were proposed in many countries.

5. <https://www.unescap.org/resources/policy-reponses-covid-19-transport-connectivity-asia-and-pacific>

6. Unlike the issuing of directive 2012/34/EU in the EU that followed calls for support from international railway organizations https://www.railjournal.com/news/ec-proposes-economic-relief-measures-to-support-rail-through-pandemic/?utm_source=&utm_medium=email&utm_campaign=17474

Table 1. Selected measures by railways of the region during COVID-19

China	Additional national and international rail freight services were launched or enhanced during the COVID-19 outbreak (e.g. a rail-based freight services to Wuhan, increased frequency of transcontinental train services and ocean-to-rail services). The National Development and Reform Commission said in July allocated 200 million yuan (28.3 million US dollars) from the central budget to support the construction of transportation hubs in five freight assembly cities: Zhengzhou, Chongqing, Chengdu, Xi'an and Urumqi ⁷ .
Georgia	Within the framework of the measures to prevent the spread of COVID-19, movement of the freight vehicles through the customs checkpoint on Georgian-Azerbaijani border (including transit and rail freight traffic) is ensured according to the specially developed protocol in 24-hour regime.
India ⁸	A set of measures to boost freight transportation by rail via tariff and non-tariff regulations, as well as communication initiatives (like publication of direct contact numbers and website details which can be accessed by traders for transporting freight was set up by Indian Railways.
Islamic Republic of Iran ⁹	The railway of Iran (RAI) installed wagon disinfecting tunnel at Kapikoy border with Turkey for accepting and dispatching wagons via Razi border. It is observing health protocols for railway personnel by supplying personal protection equipment. All the technical data of disinfection equipment and tunnels at the borders shared with railways of Turkmenistan and railway borders reopened on 10 June 2020.
Kazakhstan ¹⁰	All railways-related processes to be carried out remotely in electronic system. The system allows customers to pay fees, fines without leaving home. In addition, for the period of the state of emergency, KTZ (national railway administration) abolished fines, fees and charges associated with the carriage of goods

7. <http://epaper.chinadaily.com.cn/a/202008/11/WS5f31ecafa3107831ec7542fa.html>

8. <https://zeenews.india.com/economy/indian-railways-takes-several-initiatives-in-tariff-non-tariff-field-to-boost-freight-operations-amid-covid-19-challenges-2306001.html>; <https://www.transportjournal.com/fr/home/news/artikeldetail/indian-railways-seizes-opportunity.html>

9. https://www.unescap.org/sites/default/files/5_Session%202_Iran.pdf

10. <https://www.railjournal.com/regions/europe/irj-in-brief-coronavirus-cd-partially-resumes-services-ns-builds-ventilator-powerpacks-china-donates-face-masks-to-mav/>

Kyrgyzstan	Kyrgyz Temir Zholu (national railways) waived charges, fees or penalties for storing cargo on the container site and on the wagon located at Kyrgyz Temir Zholu railway stations. The company also reduced the cost of transportation by rail for coal exporters by 30 percent, at a distance of up to 30 km for the Southern branch of Kyrgyz Temir Zholu.
Russian Federation	<p>RZD (Russian Railways) set up an Emergency Response Center to support shippers and enhance coordination of all links in the transport chain. Also, a simplified procedure for remote interaction with freight customers has been established.</p> <p>The Government of the Russian Federation proposed reduction of rail transportation tariffs through subsidizing the carriers. Subsidies will vary from between 25.000 and 77.000 roubles depending on the type as well as the destination of the transit cargo¹¹. The new measure covers transit routes between ports on the Pacific, Baltic and Black seas, as well as checkpoints on the border with Finland, Belarus, Poland and Azerbaijan.</p>
Uzbekistan	Uzbekistan Railways developed a software for processing and providing preliminary electronic information to customs authorities for goods transported by rail. Uzbekistan Railways extended until the end of 2020 a 30 percent discount on the transportation of all goods transported through Uzbekistan to the south of the Kyrgyz Republic and in the opposite direction.
Viet Nam	Viet Nam railway continued in freight operations with China after due precautions that included 100 per cent equipped with anti-epidemic tools such as glassed, PPEs, masks and clothing. The documentation related to trains is also decontaminated ¹² .
Turkey	Turkish Railways is undertaking freight transport with Iran without human contact and all freight trains are disinfected both before and after the trip.

11. <http://government.ru/en/docs/40269/>

12. https://www.unescap.org/sites/default/files/10_Session%202_VietNam.pdf

D. Impact of COVID-19 on railway freight along the Trans-Asian Railway network

The section dwells on the impact the crisis has and would have on rail freight from two perspectives- connectivity and freight flows/ markets that are further explained below.

(a) Connectivity

The situation caused by pandemic is characterized by differences in passenger and freight connectivity due to full or partial closures of national borders and border crossing procedures. Going forward there would be challenges related to easing of border crossing restrictions or partial restrictions depending on the how the pandemic situation evolved in each country. This could lead to high level of uncertainty regarding further restrictions, decreasing planning period for freight shippers and all other stakeholders. Potentially asynchronous actions by countries and significant differences in admission rules from country to country and additional health checks for personnel accompanying the cargo through the border crossings (if any necessary) will be other challenges on rail connectivity and this could reduce first and last mile connectivity.

The pandemic has given encouraged e-connectivity and overall digitalization of rail freight transit and use of electronic documents that could further boost the comparative advantages of railway freight

There are several opportunities arising from the pandemic having implications for connectivity. In short run they include priority/ green lanes for transit freight trains introduced by many countries. Also, railway border crossings have less restrictions than road leading to balance shifting towards rail freight. Over long term railways freight could become even more competitive for international and national connectivity as it is faster (than sea), cheaper (than air), and requires less staff (than trucks). The pandemic has given encouraged e-connectivity and overall digitalization of rail freight transit and use of electronic documents that could further boost the comparative advantages of railway freight.

(b) Rail freight flows and market

The distinctive feature of this double crisis is that not only freight volumes and market shares would change but also geography of transportation and the structure of market due to the disruption of supply chains and asynchronous actions by railways. Many of the current expectations are based on 'baseline' or even optimistic economic assumptions not considering potential impact from de-globalization that the pandemic may lead to.

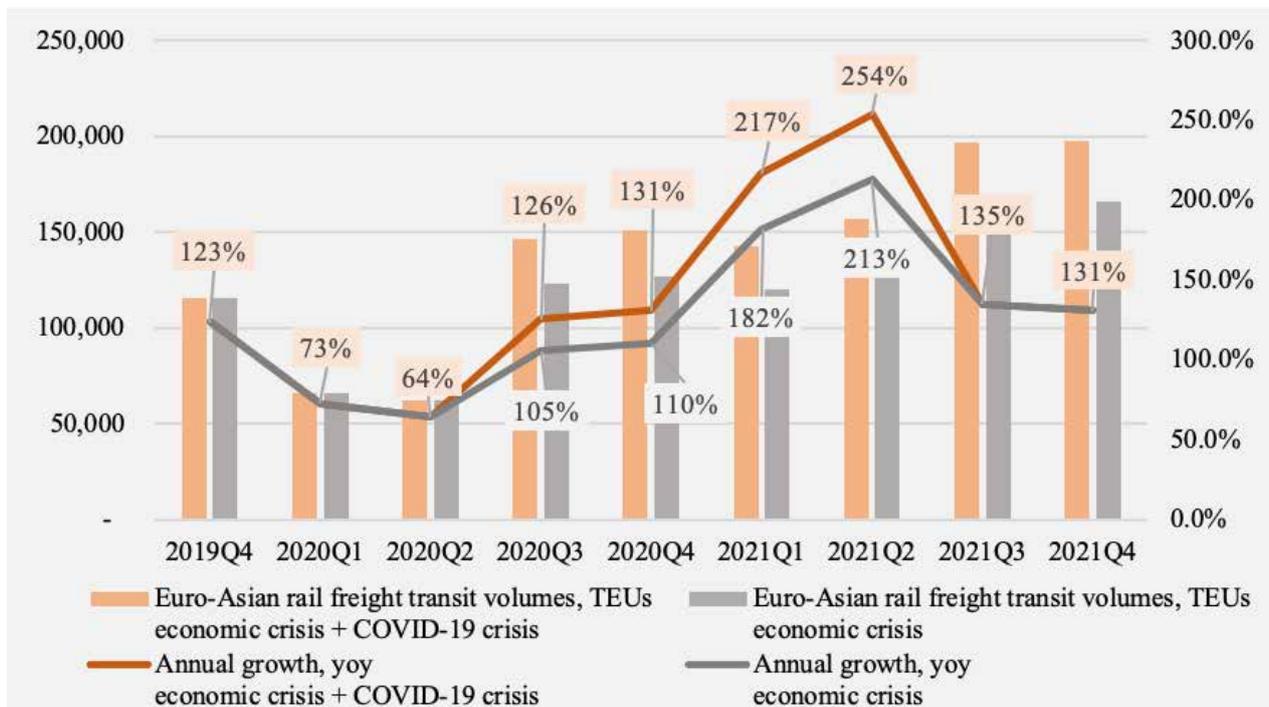
Accordingly, key challenges to rail freight flows would come from slowdown of economic growth and therefore of regional and international trade. Prolonged slowdown could disrupt the supply chains resulting in suspension of some rail services such as project-based logistics. However, in short term under shipment of goods and the necessity for fast, reliable and relatively cheap transportation services of medical goods till the pandemic persists may result in higher demand on fast rail services.

As the active spread of COVID-19 and related changes in freight transport started in 2020, not much data is available to assess likely impact. What can still be predicted is the difference between cyclic economic crisis (slowdown) that has been developing since the end of 2019 and additional pandemic crisis.

While cyclic economic crises lead to slowdown in growth, decrease in demand and decline in volumes - the COVID-19-related crisis, which is spreading faster, has resulted in under-delivery of already produced goods. This lack of supply which varies significantly for commodities needs to be addressed after containment measures are lifted and that provides short-term opportunities of larger transport volumes (+20-40 per cent in comparison to situation without pandemic)) for railways - which is faster than sea and less exposed to risks of transport restrictions than roads. This is clear given the freight flows for transit Euro-Asian routes via Kazakhstan, notably via Dostyk and Russian Federation and Belarus, were 75 percent higher in the second quarter of 2020 than for same quarter in 2019.

Fig. 3 indicates possible impact of economic crisis and pandemic on rail freight flows. It indicates growth of rail freight traffic by quarters in percentage to previous year (123 per cent in Q4 2019 means +23 per cent to Q4 2018). Overall traffic increases in 2020 and 2021 in comparison to 2019 following trade growth. Additional volumes (annual growth line indicated in orange) related to the pandemic cause a higher increase than the one that could be predicted before COVID-19 outbreak.

Figure 3. Possible impact of economic crisis and the pandemic on railway freight flows¹³



Source: IEC modelling with TMF software based on JPMorgan and ING forecasts (as of April 1, 2020)

13. Note: This chart does not intend to provide any projections of freight volumes or timeline of changes, it is supposed to illustrate the peculiarities of COVID-19 pandemic impact on rail freight transportation.

Still in 2021 the growth rate of volumes will most probably slowdown due to an expected slowdown in both Asian and especially European economies. Additional rail flows generated by specific conditions of the pandemic could partly or fully (depending on additional measures of support from governments and joint strategies of rail market stakeholders) disappear due to shift back from rail to road, maritime and air transportation of general cargo, postal flows and e-commerce goods, as well as to no demand for medical cargo flows.

A prolonged pandemic with significantly asynchronous trends of COVID-19 spread and recovery in Europe and Asia would deepen economic crisis further decreasing demand and under-delivery. In any case, COVID-19 pandemic has led to disruptions and could even permanently impact the regional and global supply chains

A prolonged pandemic with significantly asynchronous trends of COVID-19 spread and recovery in Europe and Asia would deepen economic crisis further decreasing demand and under-delivery. In any case, COVID-19 pandemic has led to disruptions and could even permanently impact the regional and global supply chains. Despite the challenges, railways would have chance to become a remedy for quick restoration of Euro-Asian links due to inherent advantages- faster, flexible in volumes (also suitable for smaller amounts and parcels), coverage of long distances and lower prices in comparison to air.

IV. Opportunities for sustainable transport connectivity along Trans-Asian Railway network during and in aftermath of COVID-19 pandemic

Following impacts of the COVID-19 pandemic would be long-lasting for railways and will have to be considered within both strategic documents and applied solutions and technologies: (i) higher predictability and reliability; (ii) digitalization and automation to reduce physical interaction; (iii) harmonization of border-crossing formalities; and (iv) electronic exchange of information between railways and among stakeholders. Based on above some of the areas where railways of the region could focus in medium to long term to shift freight to railways to enhance sustainability of transport network post the pandemic could include:

A. Digitalizing railways

Though international railway transport has been quite resilient during the pandemic, yet the crisis unleashed by COVID-19 pandemic provides an opportunity for railways of the region to further increase its comparative advantages by deepening digitalization in railways. The railway freight has been facing major competition from road which is going to further intensify with emergence of transformative transport technologies as autonomous vehicles, high capacity trucks, platooning, on demand mobility services.

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Railways themselves are in the midst of a major transformation driven by emerging digital technologies like 5G, big data, cloud computing, internet of things, automation, artificial intelligence, and blockchain. Post COVID-19 digitalization offers huge prospects for railways, owing to the numerous benefits it can provide that include improved capacity, traffic management, reliability, energy efficiency, services and lower operating costs.

However, digitalization of railways presents a formidable challenge, given the divergence in railway development among countries of the region and therefore needs to be managed with systematic and staggered approach that can be duly supported by ESCAP's intergovernmental platform. There is considerable disparity in financial investments in digital infrastructure, research and innovation, and digital skills in the region that needs to be considered.

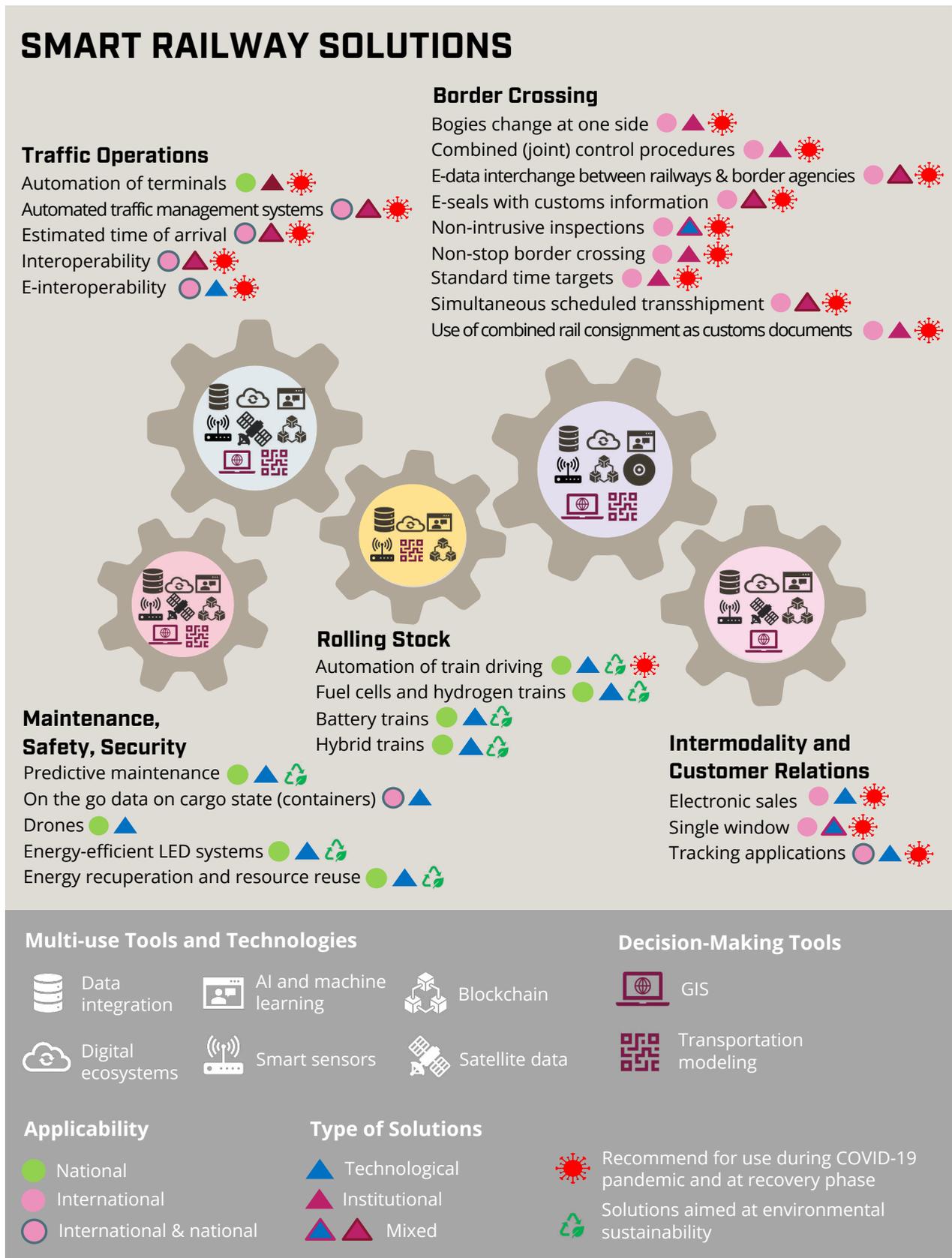
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The areas where digitalization can be scaled up needs to be identified and a regional action plan needs to be developed particularly for railways of landlocked and least developing countries to enable them to leapfrog to digital technologies. Some of areas where digitalization could be pursued rolling stock and fixed asset maintenance, railway operations, rail safety as may be seen in the Fig 4.

In addition, the switch from electromechanical devices to electrical and then digital components or the implementation of automated systems is in itself not most difficult aspect as much as developing a new mindset and approaches.

The change in mindset could by far might prove more complicated challenge for railway authorities and companies, which will have to share data and consolidate business resources since rail digitalization modifies the business model, which must evolve from a rather rigid model towards a more dynamic network joining suppliers, technological platforms, mobility providers and customers. This would need considerable policy advocacy and high-level political support including capacity enhancement of railway officials to manage the transition to digital railways. Moreover, rail digitalization would have to deal with threats from cyber-attacks and need a comprehensive strategy to counteract them to secure rail assets. According to an IBM study, cyber-attacks on industrial automated control systems

Figure 4. Possible areas for digitalization in railways¹⁴



14. https://www.unescap.org/sites/default/files/2_Session3_IEC.pdf

increased by more than 600 per cent between 2012 and 2014 and specialists consider rail networks to be potential cyber-attack targets. The challenge is both human and technical.

The railways of the region have expressed the need to have common approach for digitalization of railways. In this regard, the Joint ESCAP-OSJD Virtual Meeting of Experts on Challenges and Opportunities for International Railway Transport along Trans-Asian Railway Network in the times of COVID19 pandemic organized on July 2020 underscored the importance of digitalization of railways to further enhance efficiency of railway transport. The meeting recommended the ESCAP secretariat considering developing a comprehensive framework for digitalizing railways in the ESCAP region for further consideration by the relevant intergovernmental bodies.

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B. Electronic exchange of information between railways

Efficient completion of railway border crossing processes hinges crucially on the availability of information on various aspects of freight train that is required by neighboring railways and by regulatory authorities to complete the formalities.

Initiation and completion of the railway operations and regulatory formalities at the railway border crossing requires information mainly on three aspects (a) estimated time of arrival and deviations, if any, for scheduled trains; (b) consignment note is standardized and includes data elements such as: consignor, consignee, goods information (harmonized nomenclature and description), destination or delivery point, commercial specifications, freight rates and additional services fees levied by the railway undertaking, invoicing and payment instructions, and weights; and (c) wagon list containing information on the wagons to be handed over to next railways using documents as specified/agreed.

Electronic exchange of information among railways could enormously enhance the efficiency of processes at the border crossings. When the information required is exchanged electronically the organization of the processes at railway border crossings could be significantly streamlined. As of now, many countries in Europe are harnessing the advantages of electronic interchange of data among railway undertaking

Many ESCAP member countries are also taking steps to introduce electronic interchange of data and enhance the efficiency of international railway operations. The railways of Russian Federation have advanced solutions for electronic information interchange among many railways. Electronic sharing of information regarding railway operations is agreed on bilateral level between the railways of Russian Federation and number of countries (e.g. Belarus, China, Mongolia, Baltic, some Nordic and CIS countries) and the electronic information exchange already implemented with most of them. Other countries in the region are also developing electronic exchange of railways data with the partner railways.

The electronic information exchange among railways could significantly enhance efficiency of information exchange. However, a lot of challenges remain to harness their potential along the international railway corridors. The electronic exchange solutions being historically determined by the variety of applicable legal requirements and principles of functioning of 1435 and 1520 mm railway gauges and their business demands.

Harmonization of railway electronic information exchange is already supported with: the OSJD¹⁵ solutions as described in relevant OSJD leaflets; the COTIF¹⁶ Uniform Technical Prescription on Telematics Application for Freight equivalent with the Telematics Application for Freight - Technical Specifications for Interoperability; and initiatives on introduction of common electronic CIM/SMGS consignment note by the International Rail Transport Committee.

15. Organization for Cooperation Between Railways (OSJD)

16. Intergovernmental Organization for international carriage by Rail (OTIF annexes)

However, presently, many countries in the ESCAP region are neither members of OSJD nor COTIF and most of them are expanding their international railway transport. If their systems and message exchanges for operation of freight trains could be aligned with the wider railway networks, it would ensure efficient flow of information among railways and control authorities for efficient completion of border crossing formalities. The issue of electronic information exchange between railways and among railways and controls agencies, got heightened attention from the railway of the region at Fifth Meeting of the Working Group on Trans-Asian Railway network that took place in December 2019.

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The Working Group¹⁷ recognized that electronic information exchange among railways lacking coherence could potentially lead to diverse ways of exchanging information electronically. Accordingly, to support the harmonization of such initiatives in the region, the Working Group requested the secretariat to take further steps in facilitating expert discussions and consultations among interested member countries with the goal of identifying good practices, performance indicators and possible multilateral arrangements, including an annex or protocol to the Intergovernmental Agreement on the Trans-Asian Railway Network, in that area.

C. Harmonizing customs and other government agencies formalities

Completion of regulatory formalities is a major activity undertaken at the railway border crossings. In this regard, lot of information and documents are exchanged among railways, Customs and other government agencies-that include, but not limited to, border

17. Para 17 on the Working Group report on Trans-Asian Railway network available at: https://www.unescap.org/sites/default/files/6E_Final%20report_TARWG.pdf

security guards, immigration, sanitary, food safety, veterinary, phytosanitary. With paper documentation, the formalities begin once the authorities receive the documents physically that slows the process of completing the controls as no advance decision on goods can be taken.

Moreover, differences continue to exist on the requirements for completion of the customs formalities for international transit by railway among countries on such issues as: submission of customs transit declaration; undertaking physical inspections; guarantee requirements for railway transit and related procedures; lack of mutual recognition of control measures; and documentary and information requirements. In addition, lack of linkages between electronic information systems of railways and control authorities in many countries inhibits sharing of information and use of new technologies in completion of control measures.

To support the increase in volume of goods transported by railways there is need to exploit full benefit of new technologies, including electronic exchange of information, for enhancing efficiency of regulatory controls. An appropriate legal arrangement for harmonization of customs formalities for international railway transport using modern technologies could be considered in this regard. This instrument would draw from the good practices that are currently scattered in various other agreements/conventions. Moreover, considering different state of development electronic systems of railways and control agencies in the countries, its implementation could be staggered and in conjunction with the existing paper-based systems.

An electronic single window for railway transport could be contemplated at the railway border crossings using modern technologies. The railways and the government agencies require many common information, documents and certificates to complete the formalities. For example, information on description of goods and loading/unloading places are usually required by railways, Customs, quarantine and health inspections. The data collected from multiple sources such as: electronic systems of railways, customs, immigration; automatic control equipment's; and dynamic scanners

could be stored in a neutral platform or the single window for railway transport. It can then be accessed by control authorities at the railway border crossing for completion of regulatory formalities.

Linking railway information systems with the systems of other government agencies, with national single window facility and with the information system of the carriers would lead to efficient information exchange particularly reducing the need for resubmission of similar information. Introduction of cross border electronic information exchange among related government agencies can contribute to smooth cross-border operations and reduction of delays at the railway border crossing. It aids risk management and therefore the efficiency of controls to be conducted by Customs and other government agencies. Electronic information exchange between government agencies at the railway border crossing could also be considered for efficient completion of controls.

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D. Decarbonizing railways transport

The COVID-19 pandemic has disrupted the regional economies badly, however the economic and social consequences of the pandemic should not weaken the resolve of the countries to pursue and deepen sustainability in transport sector. Already transport contributes to around quarter of global emissions and within that road transport contributes to around three quarters. Though the carbon footprints of railways are not as deep, nonetheless, given ambitious global targets to reduce carbon emissions every effort is worthwhile. In this direction, zero emission railway transport could

be a goal worth pursuing. To make railways carbon free replacing diesel with alternative traction power is critical. This requires good understanding of the existing technologies, available supporting infrastructure, and financial position of the railways.

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Electrification has been around in railways for more than a century and for many railways of the region it remains a priority. While electrification reduces the carbon footprint of railway directly, however, if the electricity is generated from fossil fuels, indirectly there would be emissions attributed to railways. Therefore, efforts need to be exerted to promote use of renewable energy in electricity generation for use in railways.

In the meantime, solutions such as state-of-art battery, hydrogen and hybrid technologies are becoming viable alternatives for diesel traction. While electrification remains preferred way to further decarbonize rail sector- the new technologies can be used where electrification is challenged either due to economical or technological reasons. Today battery trains can cover up to 100km without overhead lines. Emission free hydrogen trains are in operations since 2016. It is therefore paramount to promote and invest in charging and related infrastructure to further reduce emissions from rail. To achieve quick progress in decarbonizing rail, existing diesel rolling stock need to be substituted with alternative and innovative drive technologies particularly where overall electrification cost is prohibitive.

In addition, innovative solutions are also required to further enhance energy efficiency in the railway transport as reducing overall energy consumption would contribute in maintaining the pre-eminent position of railway as sustainable transport mode. Digitalizing railway operations could significantly enable energy efficient operations, for example, automatic train operations (ATOs)

can contribute to optimize energy consumption by trains, on board energy meters can monitor energy consumption, use of LED lighting and modern cooling and heating systems and reduce overall energy usage.

Table 2. Relative benefits of alternatives to diesel traction¹⁸

Decarbonizing solutions	General strengths	Key applications
Battery-powered traction	Easy recharging of batteries with pantographs on sections with catenary, little additional infrastructure required	Shunting in yards with significant idle times Multiple-units or locomotives on partly electrified lines that serve to recharge batteries
Hydrogen fuel cell	Operation possible over longer non-electrified routes than with battery traction Larger numbers of trains can be supplied by a central hydrogen refueling infrastructure Fast refueling (compared to recharging batteries)	Shunting mixed with main line delivery to sidings over distances up to 200 km Multiple units / main line locomotives for routes with longer non-electrified sections Cross-border traffic with different power systems
Electrification with catenary	Unlimited access to electricity, high power range possible Energy recovery without the need for storage Lower weight / volume (no batteries / H2 tank) Economical if capital expenditures and operating cost are spread over a high number of trains	High speed rail traffic Long / heavy freight trains Passenger trains with frequency of at least two trains per hour

18. <https://www.railwaygazette.com/in-depth/accelerating-the-decarbonisation-of-rail/55086.article>

Given, the benefits that would accrue from decarbonization of railways, ESCAP secretariat is working to develop recommendations for member countries on way to further deepen the sustainability in railway transport. The recommendations would be presented to the Working Group on Trans-Asian Railway network at its next meeting.

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E. Railways - backbone of integrated intermodal transport

The railways traditionally had captive markets in mining and movement of bulk commodities mainly owned by public sector. Assured captive markets led railways to focus more on infrastructure building than on understanding markets and changing customer requirements. Moreover, in many emerging and least developing countries railways serve multiple objectives including social and political. Therefore, most railways started to lose commercial orientation and become more dependent on public funding- setting up of vicious cycle of underinvestment in railway as shown in the figure below.

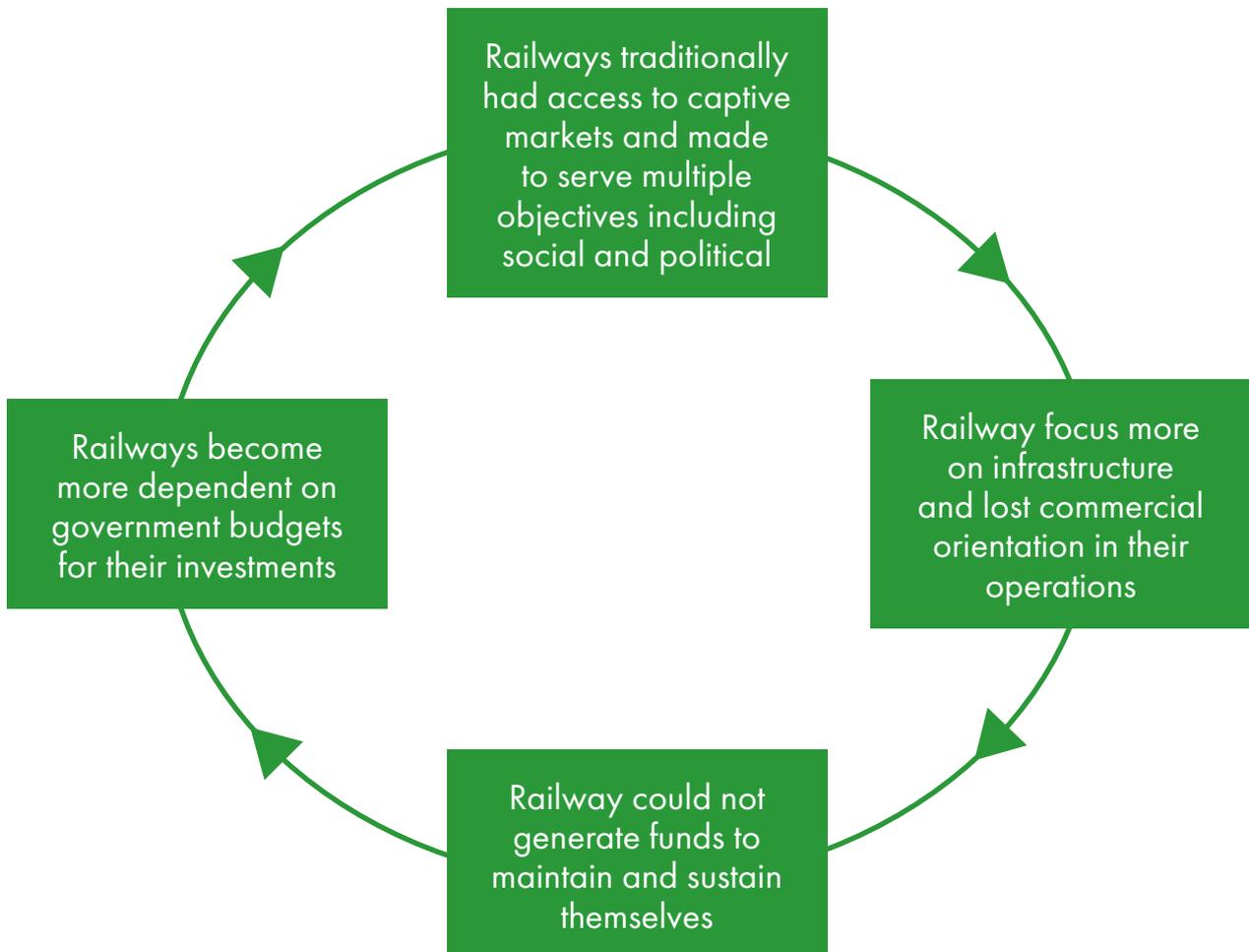
Efforts to stem falling share of railways has been on improving internal processes and operations as well as underscoring the cost advantage of moving freight by railway. Improving operational efficiency is important but this in itself cannot lead to a significant shift of freight to railways. The changing landscape of global logistics in which several modes of transport can be used in a supply chain based on total logistics cost has encouraged shippers to use alternate modes such as road and air transport despite their having considerable negative externalities.

Experience of successful railway reveal that they focus on operation efficiency and take holistic view of the supply chain from the perspective of various stakeholders such as shippers, freight forwarders and third party logistics providers and railway freight is viewed as a part of the end to end transport solution to minimize the cost from origin to destination. Studies and practical experience

indicate that reliability, price, flexibility of service, and security of critical consideration in choosing mode of transport. For example, shippers in time sensitive freight category place reliability above cost as for many containerized goods, inventory carrying cost is much higher than transport costs. Railway need to become competitive, efficient and reliable to be part of the end to end supply chains. ESCAP through its normative and analytical work supports member countries in developing integrated intermodal transport system with railway at its backbone.

Experience of successful railway reveal that they focus on operation efficiency and take holistic view of the supply chain from the perspective of various stakeholders

Figure 5. Vicious cycle of under investment in railways



F. Bundling of freight through strategic location inland ports

To increase modal share by railway, it is imperative to enhance the freight flows on long distance railway corridors. However, in many countries in the region, the modes of surface transport are not integrated to allow for synergies and complementarities. The fragmented networks are not able to support the rising demand for freight and changing production patterns due to emergence of value chains in a sustainable manner. Lack of integrated planning and investment in freight transport infrastructure has led to inefficiencies that have contributed to increased logistics cost.

...there is a need to create strategic hubs at the dry ports along the Trans-Asian Railway network to bundle the cargo to generate sufficient freight flows to allow for rail centered logistics

The main challenge in enhancing freight flows along the railway corridors is bundling of freight cargo. Bundling of freight cargo is possible by locating activities that generate and attract cargo in the vicinity dry ports. Therefore, there is a need to create strategic hubs at the dry ports along the Trans-Asian Railway network to bundle the cargo to generate sufficient freight flows to allow for rail centered logistics. This would require heightened coordination among agencies responsible for different modes of transport as well setting up of strategic hubs to pave way for more integrated transport and logistics networks.

G. Partnering with key stakeholders to attract freight to railways

For railways to be part of end to end transport solution and increase its modal share, railways need to build strategic partnerships with key shippers, freight forwarders, third party logistics providers either through affiliated companies or forging other mutually acceptable arrangements. The partnership with third party logistics provider could help bring more customers to railways, particularly the shippers, that may be reluctant to manage the complexity of intermodal chain and have reservations

about reliability of railway transport but have trust in the third-party logistics provider.

The increasing freight transport through China-Europe freight trains offers enormous opportunities for railways to forge meaningful partnerships with various stakeholders and increase their modal share

Railways in North America attracted lot of customer by partnering with third party logistics provider like United Parcel Service (UPS). In turn, these companies benefited by providing lower cost to the customers. Analysis of logistics chain and understanding of how railways could fit to offer end to end solutions could open range of opportunities for railways of the region. The increasing freight transport through China-Europe freight trains offers enormous opportunities for railways to forge meaningful partnerships with various stakeholders and increase their modal share

V. ESCAP role in fostering railway transport in the region

ESCAP is in a unique position to offer to all its member countries an institutional platform for achieving the higher competitiveness of the international railway transport. ESCAP facilitated intergovernmental agreement on Trans-Asian Railway Network is an example for countries to leverage ESCAP's intergovernmental platform to develop regional goods for realization of Agenda 2030 on Sustainable Development. The Agreement, that entered into force in 2009, provides for a coordinated plan for the development of railway lines of international importance to develop a regional railway network to meet the increasing needs inter and intra-regional trade and people to people connectivity. The Working Group under the agreement that meets once every two years provides a regional platform to deal with persistent and emerging challenges as well as harness evolving opportunities for international railway Transport.

ESCAP has built strategic partnerships with railway organizations such as Organization for Cooperation Between the Railways, Intergovernmental Organization for International Carriage by Rail, International Union for railways and other relevant international entities to support the efforts of the railways of the region in this direction.

ESCAP would strive to fill the gaps to build consensus on persistent and emerging issues and provide high level political support for the development of railway transport in the region and beyond

In promoting railway transport ESCAP would act as a facilitator offering intergovernmental platform to the railways of member countries; undertaking normative and analytical work to support evident based policies to foster railway transport; and render technical assistance based on the request from the railways. ESCAP would strive to fill the gaps to build consensus on persistent and

emerging issues and provide high level political support for the development of railway transport in the region and beyond.

Enhancing competitiveness of railway transport is a challenging and long-term task for railways of the region and requires cooperation of railways, adaptability of railways to the market demands and continuous improvement of the quality of railway services. The potentially deeper involvement of the ESCAP in railway transport would help the member countries to enhance competitiveness of railways of the region in a coordinated approach using working methods adapted to the requirements of each country.

VI. Conclusions

COVID-19 has given a massive blow to transport connectivity both at regional and global levels by suffocating the supply chains. It would take quite some time for economies of the region to come of it. The wide scale disruptions cause by the COVID-19 pandemic would undoubtedly make the path towards realization of the 2030 Agenda for Sustainable Development more challenging. However, history is replete with challenges faced by the mankind and its resilience to come better out of them. The crisis must be seen by the railways of the region as an opportunity to further solidify its credentials as the most sustainable mode of transport.

The process of digitalization of various aspects of railways that had begun much before the crisis hit should be further broadened and deepened across the railways of the region. In this regard a regional framework/strategy for digitalization of railways in ESCAP region could act as a catalyst for bigger change. ESCAP has already started to put such as framework together with objective of identifying issues in railway operations, maintenance and infrastructure that could be digitalized and scaled up across the region so that the benefits of digitalization can be harnessed by railways, particularly of landlocked and least developing countries.

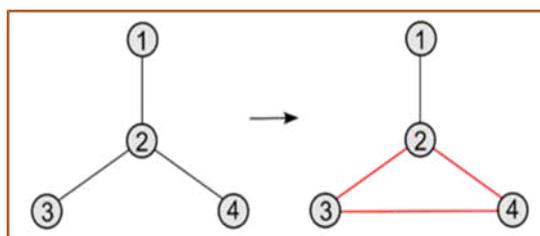
While digitalization would promote economic efficiency, it would also support decarbonizing railways by enhancing energy efficiency- an objective -that itself needs to be pursued. Also, to support decarbonizing railways in the region- ESCAP is working to develop recommendations that would provide options for railways to further decarbonize and move towards zero emissions from rail.

If the opportunities for railway as indicated above are harnessed optimally, it would made rail a preferred mode of transport for shippers and ultimately attract freight to railways- supporting modal shift towards more sustainable modes of transport that many countries are pursuing. Over medium to long-run, concrete action on these initiatives, would greatly enhance the efficiency of international freight trains and further reduce transport time as

well cost and boost sustainability of international railway transport, helping the region “build back better” and shift to a new, more sustainable, “normal” in the post-COVID-19 world.

Annex. Methodology of topological connectivity evaluation

Trans-Asian Railway Network is presented as a mathematical graph¹⁹ with vertices (nodes) being hubs (stations/cities of origin, intersections of railway lines, and border-crossings) and edges being railway lines. Connectivity is calculated as a number of cycles (or closed graphic figures) within the graph. If a node disappears, linked edges are automatically considered as non-working.



α index is used to evaluate the connectivity:

$$\alpha = \frac{\mu}{\mu_{max}}$$

(1),

where μ - is a number of cycles within the graph, μ_{max} - maximal number of possible cycles available for the graph. is calculated as follows:

(2) where v - number of vertices (nodes) of the graph.

The closer α index is to 1, the higher is connectivity.

This is a simplified, a topologic way to calculate the connectivity.

19. https://en.wikipedia.org/wiki/Graph_theory

List of border crossings considered for calculation of connectivity index

No	From	From (country)	To	To (country)
1	Hekou	China	Lao Cai	Viet Nam
2	Pingxiang	China	Dong Dang	Viet Nam
3	Alashankou	China	Dostyk	Kazakhstan
4	Erenhot	China	Zamyn Uud	Mongolia
5	Manzhouli	China	Zabaykalsk	Russian Federation
6	Suifenhe	China	Grodekovo	Russian Federation
7	Astara	Islamic Republic of Iran	Astara	Azerbaijan
8	Jolfa	Islamic Republic of Iran	Djulfa	Azerbaijan
9	Sarakhs	Islamic Republic of Iran	Saraks	Turkmenistan
10	Incheboroun	Islamic Republic of Iran	Gudriolum	Turkmenistan
11	Dogukapi	Turkey	Akhuryan	Armenia
12	Mirjeveh	Islamic Republic of Iran	Koh-i-Taftan	Pakistan
13	Sukhbaatar	Mongolia	Naushki	Russian Federation
14	Sary-Agach	Kazakhstan	Keles	Uzbekistan
15	Khodzhadavlet	Uzbekistan	Turkmenabad	Turkmenistan
16	Razi	Islamic Republic of Iran	Kapikoy	Turkey
17	Beyouk Kesik	Azerbaijan	Gardabani	Georgia
18	Woodlands	Singapore	Johor Bahru	Malaysia
19	Padang Besar	Malaysia	Padang Besar	Thailand
20	Raxaul	India	Birgunj	Nepal
21	Tobol (Aksu)	Kazakhstan	Kartaly	Russian Federation
22	Ganyushkino (Diny Nurpieisowo)	Kazakhstan	Aksaraiskaya (Kigrash)	Russian Federation

No	From	From (country)	To	To (country)
23	Zernowaya	Kazakhstan	Zauralje	Russian Federation
24	Kurkamys	Kazakhstan	Kulunda	Russian Federation
25	Petropavlosk	Kazakhstan	Petukhovo (Petropavlosk)	Russian Federation
26	Jalama	Azerbaijan	Samur	Russian Federation
27	Nikeltau (Kirkgilda)	Kazakhstan	Orsk	Russian Federation
28	Aul	Kazakhstan	Lokot	Russian Federation
29	Karsava	Latvia	Skangali	Russian Federation
30	Zilupe	Latvia	Posin	Russian Federation
31	Ijevan	Armenia	Barkhudarly	Azerbaijan
32	Yeraskh	Armenia	Belidag-Ordubad	Azerbaijan
33	Niuvedi	Armenia	Agbent	Azerbaijan
34	Ayrum	Armenia	Sadakhlo	Georgia
35	Darsana	Bangladesh	Gede	India
36	Rohanpur	Bangladesh	Singhabad	India
37	Birol	Bangladesh	Radhikapur	India
38	Shahbazpur	Bangladesh	Mahيسان	India
39	Poipet	Cambodia	Klong Luk	Thailand
40	Dandong	China	Sinuiju	Democratic People's Republic of Korea
41	Tumen	China	Namyang	Democratic People's Republic of Korea
42	Bongdong (Southernmost station)	Democratic People's Republic of Korea	Dorasan	Republic of Korea
43	Onjongri	Democratic People's Republic of Korea	Jejin	Republic of Korea
44	Tumangang	Democratic People's Republic of Korea	Khasan	Russian Federation
45	Gantiadi	Georgia	Veseloe	Russian Federation
46	Attari	India	Wagah	Pakistan
47	Lugovaya	Kazakhstan	Bishkek	Kyrgyzstan

No	From	From (country)	To	To (country)
48	Semiglavii Mar	Kazakhstan	Ozinki	Russian Federation
49	Uralsk (Chinghirlau)	Kazakhstan	Ilets'k I	Russian Federation
50	Aktobe	Kazakhstan	Ilets'k	Russian Federation
51	Oazis	Kazakhstan	Karakalpakiya	Uzbekistan
52	Thanaleng	Lao People's Democratic Republic	Nongkhai	Thailand
53	Rantau Panjang	Malaysia	Sungai Kolok	Thailand
54	Nau	Tajikistan	Bekabad	Uzbekistan
55	Kanibadam	Tajikistan	Suvanabad	Uzbekistan
56	Pakhtaabad	Tajikistan	Kudukli	Uzbekistan
57	Khoshad	Tajikistan	Amuzang	Uzbekistan
58	Gazodjak	Turkmenistan	Pitnyak - K.P.449	Uzbekistan
59	Dashowuz	Turkmenistan	Urgench	Uzbekistan
60	Takhyatash	Turkmenistan	Naymankhul	Uzbekistan
61	Galaba	Uzbekistan	Khairaton	Afganistan
62	Andizhan	Uzbekistan	Osh	Kyrgyzstan
63	RZD 154	Uzbekistan	Talimarjan	Turkmenistan
64	Termez	Uzbekistan	Kelif	Turkmenistan