Strategy 2030 on Accelerating Rail Digital Transformation in the Asia-Pacific region

ESCAP
Economic and Social Commission for Asia and the Pacific

The Strategy 2030 on Accelerating Rail Digital Transformation in the Asia-Pacific region was adopted by the Eighth Meeting of the Working Group on Trans-Asian Railway held in September 2023.

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Table of Contents

Executive Summary

1. The coronavirus disease (COVID-19) pandemic has demonstrated the resilience of rail transport while also providing further momentum to rail digitalization initiatives in the region. For example, at the seventh meeting of the Working Group on the Trans-Asian Railway Network, held in Bangkok and online on 20 and 21 May 2021, States supported the initiative to develop a regional strategy/framework to deepen digitalization among the railways of the region, especially for the benefit of the least developed countries and landlocked developing countries. At its seventh session, held from 23 to 25 November 2022, the Committee on Transport called for renewed support to enhance the transport connectivity of countries in special situations, including through continued capacity-building activities on transport connectivity and logistics and other initiatives such as the preparation of a regional strategy to accelerate rail digital transformation in Asia and the Pacific.

2. The Strategy 2030 on Accelerating Rail Digital Transformation in the Asia-Pacific Region has been prepared on the basis of extensive work done by the secretariat under two United Nations Development Account projects, namely those on trade and transport connectivity in the age of pandemics and on promoting a shift towards sustainable freight transport in Asia and the Pacific. Under those two projects, numerous activities on rail digitalization have been carried out, including the preparation of e-learning material on rail digitalization together with the International Union of Railways.

3. The key elements of the Strategy 2030 are a guiding vision, six objectives, eight priority areas and five enablers, as well as implementing arrangements, including for measuring progress in rail digitalization. The guiding vision is to enhance the sustainability of transport to support the realization of the 2030 Agenda for Sustainable Development. Digitalization is viewed as a lever to enhance rail competitiveness, facilitate the shift to rail and decrease greenhouse gas emissions from the transport sector.

4. The overarching objective of the Strategy 2030 is to accelerate rail digitalization in the region by: providing coherence and momentum to rail digitalization initiatives; fostering an ecosystem conducive to harnessing the full potential of rail digitalization; augmenting the operational performance, capacity, reliability, safety and security of rail

assets; enhancing customers' experience, including with regard to the ease of doing business; creating synergies through partnerships to digitalize rail; and ensuring high-level political support for rail digitalization. The Strategy 2030 sets out eight priority areas: digital customer services; digital communication technologies for rail; digital platforms for rail operations; digital rail asset management, including maintenance; digital traffic management, including signalling; digitally integrated rail services; digital rail business processes, to share experiences and good practices and identify appropriate solutions; and digital rail border crossing.

5. In addition, the Strategy 2030 identifies five cross-cutting issues or enablers: enhancing the digital skills of rail officials; increasing investment in rail digitalization; strengthening rail cybersecurity, including data protection; using data analytics to support optimal decision-making; and heightening engagement with the private sector. Finally, the Strategy 2030 contains implementation arrangements, including for measuring progress in rail digitalization.

6. The draft strategy was discussed at the high-level conference on accelerating rail digital transformation in the Asia-Pacific region, held in New Delhi on 5 and 6 April 2023. The participants in the conference welcomed the draft strategy and underlined that its adoption and subsequent implementation would fast track rail digitalization in the region. They requested the secretariat of the Economic and Social Commission for Asia and the Pacific to finalize the strategy on the basis of the contributions received from members and associate members and to submit the finalized strategy to the Working Group at its eighth session for adoption.

7. The digitalization of transport is one of the seven thematic areas of the Regional Action Programme for Sustainable Transport Development in Asia and the Pacific (2022–2026), which was adopted at the Fourth Ministerial Conference on Transport, held in Bangkok and online from 14 to 17 December 2021, and endorsed by the Commission in its resolution 78/3. Implementation of the Strategy 2030 will contribute to making progress not only in the digitalization thematic area, but also on the three overarching objectives of the Regional Action Programme: efficient and resilient transport and logistics networks and mobility for economic growth; environmentally sustainable transport systems and services; and safe and inclusive transport and mobility

Background

1. Rail transport is experiencing a tidal wave of digital transformation driven by emerging digital technologies like artificial intelligence, fifth generation (5G) mobile technology, big data, cloud computing, the Internet of things, automation and blockchain. These new technologies can provide numerous benefits to augment rail competitiveness by enhancing operational efficiency, lowering energy intensity, enriching customer experience, and integrating seamlessly with other modes of transport.

2. The resilience shown by rail transport during the coronavirus disease (COVID-19) pandemic has provided additional impetus to digitalize rail and harness the numerous benefits of digitalization. Improvements in the competitiveness of rail transport due to digitalization would afford opportunities for increasing the freight transported by rail and pave the way for more sustainable freight transport to support the realization of the Sustainable Development Goals. Harnessing the opportunities arising from rail digitalization presents a formidable challenge, however, given the differences in the status of rail development in the countries of the Asia-Pacific region. There are also considerable disparities in terms of research and innovation, digital skills and financial investments in rail digital infrastructure that need to be addressed. The areas where rail digitalization could be scaled up need to be identified and regional cooperation needs to be deepened, in particular to support the least developed countries and landlocked developing countries so that they can leapfrog to rail digital technologies.

3. Some areas where rail digitalization could be pursued include predictive rolling stock and fixed asset maintenance, digital platforms for railway operations and the use of big data analytics for rail planning and operations. Since rail digitalization necessarily results in modified business models – from a rather rigid structure to a more dynamic network joining suppliers, technological platforms, mobility providers and customers – the change in mindset might prove to be more challenging for rail authorities and companies, which will have to share data and consolidate business resources. Rail digitalization also brings with it challenges related to data protection and cybersecurity. To address these challenges, it will be crucial for member railways to share experiences and good practices on these interrelated issues.

4. To better understand the opportunities emerging from rail digitalization, the Economic and Social Commission for Asia and the Pacific (ESCAP) has carried out an exploratory study on smart railway solutions under a United Nations project on trade and transport connectivity in the age of pandemics. Through the study, ESCAP has looked at emerging trends in international railway transport, as well as the challenges and benefits arising from rail digitalization. The findings have been presented at various forums and met with the interest of railway policymakers in the region. Furthermore, at its seventh meeting, the Working Group on the Trans-Asian Railway Network recognized the significance of digitalizing railway transport in times of pandemic and the related emerging opportunities and supported the development of a regional strategy.

Challenges to rail digitalization in the Asia-Pacific region

5. While the benefits of rail digitalization are clear, harnessing them would mean better understanding the underlying challenges and how can they be addressed. Legacy rail infrastructure is one of the significant challenges faced by the railways in the region. For instance, replacing mechanical interlocking systems with electronic versions is not only costly but needs careful planning to avoid traffic disruptions. Adopting automatic block systems presents a similar challenge. Changes are needed not only in the equipment but also in operational and maintenance practices. Transitioning to rail digital infrastructure needs careful consideration and could be staggered.

6. Furthermore, there is the challenge of enhancing the digital skills of railway personnel, many of whom are older and may need more time to learn digital skills and adapt to a digital environment that requires innovative and out-of-the-box approaches to problem-solving. Some employees may see digitalization as a threat to their jobs and could therefore resist it. The need for capacity-building and the related cultural shift could pose significant challenges for rail digitalization initiatives and therefore must be addressed appropriately.

7. Another challenge for rail digitalization is the fact that many railway organizations operate in silos, which prevents a seamless flow of information among the various verticals that manage different aspects of rail transportation, such as tracks, signalling systems and rolling stocks. Although these entities work towards a single goal, their focus remains

on internal interests and objectives. Digitalized train operations require much greater coordination and information exchange among the different verticals indicated above.

8. For railways to become digitalized, they need to work with other stakeholders to create an ecosystem capable of delivering a complete range of digital solutions. For example, rail systems need to be linked to customers, financial institutions, ports, inland container depots and regulators such as national tax authorities and customs and other border agencies. In turn, these linkages with other stakeholders too can pose both technical and institutional challenges that need to be resolved efficiently. As most railways in Asia and the Pacific receive financing from Governments, whose budgets are constrained owing to multiple priorities, rail policymakers need to focus on finding non-traditional sources of financing for research and innovation in digital rail.

9. The digitalization of rail will create huge amounts of data, which is why data governance issues related to the availability, usability, integrity, consistency, and security of data will become of paramount importance in ensuring that data are trustworthy and do not get misused. Furthermore, data need to be protected through appropriate legislation. Cybersecurity too is a significant challenge in rail digitalization initiatives.

10. The digital divide and the uneven availability of telecommunication infrastructure in different countries in the region must be considered while planning rail digitalization initiatives.

11. Given the above-mentioned challenges, harnessing the benefits of rail digitalization in the region requires combined and sustained efforts to be made by multiple stakeholders. Much of this work should be done by railways at the national level, but their efforts need to be supplemented by development partners. It also requires undertaking policy advocacy, creating synergies through partnerships, ensuring high-level political support, and developing capacity-building programmes for railway officials to manage the transition to digital railways.

Key elements of the Strategy 2030 on Accelerating Rail Digital Transformation in the Asia-Pacific Region

12. The Strategy 2030 could support a smooth transition to rail digital transformation in the region, taking advantage of the intergovernmental platform provided by ESCAP. It comprises a guiding vision, six objectives,

eight priority areas and five enablers, as well as implementing arrangements, including for measuring progress in rail digitalization. Its implementation will result in an increase in freight and passenger transport by rail and reduce greenhouse gas emissions from transport.

A. Guiding vision

13. The guiding vision of the Strategy 2030 is to enhance the sustainability of transport to support the realization of the 2030 Agenda for Sustainable Development. Digitalization is viewed as a lever to enhance rail competitiveness, facilitate the shift to rail and decrease greenhouse gas emissions from the transport sector, thereby becoming part of the solution to address climate change.

14. Specifically, the Strategy 2030 is aimed at supporting the implementation of target 3.6 (by 2020, halve the number of global deaths and injuries from road traffic accidents), target 7.3 (by 2030, double the global rate of improvement in energy efficiency), target 9.1 (develop quality, reliable, sustainable, and resilient infrastructure, including regional and transborder infrastructure, to support economic development and human well-being, with a focus on affordable and equitable access for all) and target 13.1 (strengthen resilience and adaptive capacity to climate-related hazards and natural disasters in all countries), as well as indicator 9.a (facilitate sustainable and resilient infrastructure development in developing countries through enhanced financial, technological and technical support to African countries, the least developed countries, landlocked developing countries and small island developing States), of the Sustainable Development Goals.

B. Objectives

15. The overarching objective of the Strategy 2030 is to accelerate rail digital transformation in the region by:

(a) Providing coherence and momentum to rail digitalization initiatives;

(b) Fostering an ecosystem conducive to harnessing the full potential of rail digitalization;

(c) Augmenting the operational performance, capacity, reliability, safety and security of rail assets;

(d) Enhancing customers' experience, including with regard to the ease of doing business;

(e) Creating synergies through partnerships to digitalize rail;

(f) Ensuring high-level political support for rail digitalization.

C. Priority areas

1. Digital customer services

16. Providing good customer service is the prime objective of any transportation business and rail transport is no different. Influenced by the Internet revolution, customers now expect improved services that are supported by digital technologies. The digitalization of rail enhances the customer experience by offering better services and adds value by meeting their expectations both in the passenger and freight segments.

17. In the passenger segment, digital technologies can perceptibly improve customer satisfaction by making it possible to book tickets online, providing more informative and user-friendly websites and mobile applications, sharing real-time information about train movements and enabling a seamless travel experience through digital integration with other service providers. Digital technologies can be used to manage various passenger services at railway stations, which places them at the front line of the customer experience. In fact, the concept of digital stations is gaining increased attention. For example, digitally integrated applications are able to display real-time information on how trains are running, any delays and the platform of arrival or departure. Also, the use digital cameras with artificial intelligence data analytics capacities can detect any suspicious passenger behaviour that could be considered a threat to security, making stations safer and more passenger-friendly.

18. In the freight segment, digitalization can help by making it possible to book cargo online, estimate delivery time, use digital payment systems, generate digital railway receipts and transmit them electronically, track and trace cargo online and integrate the electronic systems of major customers and other logistics service providers.

Suggested action

19. In their national plans and strategies, members should prioritize delivering rail customer services digitally in both the passenger and freight segments. For the passenger segment, private entities could be encouraged to develop a range of digital solutions and applications, including to facilitate ticket bookings. Similarly, member railways should aim to develop a digital system to manage the freight business. By

sharing experiences among railways and providing technical assistance to the least developed countries and landlocked developing countries, it is possible to make tangible progress towards digitalizing rail customer services.

2. Digital communication technologies for rail

20. A modern communication system is fundamental for exchanging the large amount of data that is required to support rail digitalization initiatives. The existing global system of mobile communications for railways, which is based on second generation (2G) technologies, has met the needs of railways for many years and has proved to be reliable and secure. However, it makes inefficient use of the radio spectrum and uses supportive hardware that is likely to become obsolete by 2030, making the need to migrate to new technologies imminent. At the same time, for some countries this technology may not currently have a wide scope for implementation, therefore, when switching to newer communication technologies such as 5G and the accompanying hardware and software support, additional steps will be required to analyse and draw up a road map for the transition.

21. Moreover, the sheer volume of data needed to digitalize railways would inevitably require railways to shift towards fourth generation (4G) or 5G communication technologies, as these can support high-speed wireless voice, video and data communications inside trains, from trains to the ground and back, and between trains. In parallel to finalizing the functional specifications for future railway mobile communication systems, rail companies have started to implement digital solutions facilitated by innovations in wireless communication technologies, which allow for the reliable transmission of voice, video and data services over long distances.

22. Various proprietary solutions based on advanced forms of telecommunication standards that can support mission-critical characteristics (i.e. higher data rates and low-latency[1] automation) are available for railways and provide immediate opportunities for their digital transformation. Member railways should define their priorities carefully and choose technologies wisely, ensure their interoperability,

[1] The term "low latency" describes a computer network that is optimized to process a very high volume of data with minimal delay (latency). These networks are designed to support operations that require near to real-time access to rapidly changing data, which is vital for continuous connectivity for high-speed trains.

especially when planning the digitalization of activities along international corridors.

Suggested action

23. Given that digitalizing rail requires robust and varied communication technologies, rail managers in the region need to have a better understanding of the available technologies and of how they can be used, including by undertaking research and testing in various conditions and on different railway systems, with the involvement of representatives of relevant industries and experts, and by sharing experiences and lessons learned. Also, the transition to 5G-enabled train communication technologies needs to be carefully considered and managed in such a way as to avoid any negative impact on existing transportation networks and ensure the least cost. Guidelines could be developed on the use of digital rail communication technologies, specifying the measures that need to be taken, particularly by the least developed countries and landlocked developing countries, to harness all the benefits of rail digitalization, especially while planning the digitalization of international corridors and considering the possibility of harmonizing frequency bands when implementing 5G-based communication technologies in the countries of the region.

3. Digital platforms for rail operations

24. Modern railway systems use digital platforms and applications for a range of purposes, including modelling railway operations, calculating train performance, establishing timetables and creating time-distance graphs to monitor how trains are run by section controllers, dispatchers and crew managers, among others. There are number of applications to manage passenger train operations, freight train operations, crew, the rolling stock etc. These applications need to be digitally integrated in order to ensure the seamless sharing of data and improve the efficiency of data-driven train operations. For instance, applications for crew management should receive data in real time on how trains are running from the train operations application so that the correct crew are available at the next crew-changing location. The most used railway digital platforms include train running and monitoring applications, timetabling applications and freight and passenger operation and management applications. There are also applications that combine the functions of more than one of the above-mentioned applications.

25. Train running and monitoring applications are used in operation control centres and replace the tedious manual plotting of running trains

on a chart. The arrival and departure times of each train are fed, automatically or manually and on an almost-real-time basis, into the application and trains are plotted along a time-distance graph. On the basis of that information and on their priorities, section controllers and train dispatchers decide which trains take precedence and the crossings (passes and meets) of trains. Train running and monitoring applications can also help to forecast traffic conditions along the network.

26. Timetabling applications make it possible to establish and print both long-term and short-term timetables, including for operations like track work.

27. Freight operation and management applications are used to digitally manage railway freight services, including the management of wagons, the formation of goods trains, the booking of cargo, the supply of wagons, loading, the collection of freight charges, the issuance of receipts, the running and tracking of freight trains, the attachment and detachment of wagons and locomotives, the delivery of cargo at destination and the repositioning of empty containers.

28. Passenger operation and management applications are typically used for the management of passenger coaches, the formation of passenger trains, the monitoring of passenger trains against timetables, the estimation of the punctuality of trains and the logging of the causes of delays and analyses thereof.

Suggested action

29. Member railways may review the available applications and, depending on their needs, adopt them incrementally and in a digitally integrated manner to facilitate the smooth exchange of data to support optimal decision-making. Application programming interfaces and blockchain-enabled platforms can be used to integrate different applications, thereby driving information-sharing, fostering collaboration and trust, and spurring innovation. At the regional level, a repository of train operating applications using open-source platforms, including simulation applications such as digital twins, can be developed for reference and use, particularly by the railways of the least developed countries and landlocked developing countries.

4. Digital rail asset management, including maintenance

30. The efficiency of any railway system largely depends upon the availability and reliability of assets to perform the desired functions.

Railway assets can be divided into two broad categories: fixed infrastructure and rolling stock. Conventionally, railway assets are maintained through a preventive maintenance approach, for example by carrying out planned periodic maintenance. Progress in technology now allows railway engineers to also carry out condition-based maintenance, in other words to carry out maintenance when the condition of a specific asset reaches a pre-defined parameter. It is also possible to monitor the condition of assets and to determine when corrective or preventive maintenance should be carried out in order to fix or replace the asset at risk before it fails.

31. Predictive maintenance, which marks the next level of sophistication, is achieved through the automatic and real-time monitoring of equipment. Such careful monitoring can determine the root causes of failure and predict if the equipment, including subsystems and components, will fail within a given time frame. Where real-time monitoring is not yet available, several rail operators use a combination of inspections and advanced computer modelling to predict future degradation. This helps rail operators to make informed decisions about maintenance and to develop asset management strategies.

32. Predictive maintenance requires the installation of a wide array of sensors to generate real-time data on the condition of assets. Connected, intelligent devices enabled by the Internet of things can constantly track rail assets by gathering real-time data through sensors, cameras, drones and other mobile technologies and by feeding the data into analytics engines for further processing. Having such a network of devices to monitor infrastructure in real time has enormous positive implications for rail systems dealing with ageing infrastructure, especially in the areas of maintenance, repair, and operations. For example, intelligent sensors attached at intervals to a rail line can monitor changes in temperature, motion, pressure, and other factors. Feeding that data through an advanced analytics engine powered by artificial intelligence enables rail operators to identify where and when maintenance is needed before rail components show signs of compromise.

Suggested action

33. Member railways are encouraged to share experiences and learn from each other in this area, which is rapidly evolving. Particular attention should be paid to the low-cost predictive maintenance solutions that can be leveraged to reduce downtime, increase the availability of assets and lower operational costs. An inventory of good practices at the regional

level on predictive maintenance for rail could be prepared for use by member railways, as deemed fit. Member countries may develop, in partnership with private companies, a proof of concept to make a business case for the commercial roll-out of promising solutions.

5. Digital traffic management, including signalling

34. Digital traffic management systems[2] ensure the interoperability of national railway systems, reducing the purchasing and maintenance costs of signalling systems and increasing the speed of trains, the capacity of the infrastructure and the level of safety in rail transport. Digital rail signalling makes it possible for a higher number of trains to run on existing lines at optimal speeds and provides enhanced train protection. Examples of such signalling systems include the European train control system and the North American positive train control system. Systems with similar functionalities are also being used in the Asia-Pacific region: the national railway companies of both China and the Russian Federation use their own train control systems.

35. As part of the digitalization process, rail systems are shifting from mechanical to electronic interlockings, making it possible to operate more trains, thereby enhancing capacity without adding tracks. Moreover, electronic interlockings significantly improve the safety and reliability of train operations. Signalling systems are also being changed from absolute to automatic to increase the line capacity of the existing rail network. The adoption of such digital signalling systems and electronic interlockings paves the way for centralized traffic control and automatic train operations. In centralized traffic control operations, the switches and signals at stations are operated and controlled at the operation control centre, improving the efficiency and safety of train operations. It also makes it possible to manage timetables, line capacity and asset failures, as well as disasters.

Suggested action

36. Digitalizing rail traffic management should be a priority for railway managers. In some countries in the Asia-Pacific region, however, it may not be economically and financially viable in the short term. Therefore, feasibility studies should be undertaken, including to review the available

[2] The European Railway Traffic Management System, for example, is a control, command, signalling and communication software-based system for railway management and safety control. It was adopted by the European Union as a standard, allowing an interoperable rail frame in Europe. The European Railway Traffic Management System is composed of the European Train Control System and the Global System for Mobile communications for Railways.

capacity of rail infrastructure and the operating speed of the rolling stock, before adopting digital traffic management solutions. Such solutions may be introduced gradually, as rail traffic increases and the capacity of rail officials to implement them improves.

6. Digitally integrated rail services

37. To reap all the potential benefits, digital rail services should be digitally integrated with other stakeholders in the transportation ecosystem. While physical integration facilitates the smooth transfer of passengers and goods from one system to another, digital integration promotes convenience for the users and efficiency in transportation services. For example, rail freight management applications should be digitally integrated with the following:

(a) The electronic systems of major freight customers, to exchange data on the loading and unloading of freight, railway receipts and train locations;

(b) Financial institutions, including banks, to accept freight charges digitally;

(c) Private railway terminal operators, to exchange data on trains coming to the terminal and trains being handled at other terminals;

(d) Port e-systems, to exchange data on trains and containers handled at ports;

(e) National integrated logistics platforms, to share data on train movements, demand and freight charges;

(f) Warehouse service providers, to show the availability of space in warehouses;

(g) First- and last-mile logistics providers, to provide information on the availability of trucking and labour-handling companies;

(h) National e-customs systems, to exchange data on export, import and transit traffic;

(i) Weighbridge operators, to obtain weighment details electronically.

Suggested action

38. Railways will only be able to enjoy the full benefits of rail digitalization if the related services needed to complete the rail transport processes can also be digitalized. Therefore, member railways should proactively reach out to the relevant stakeholders and discuss ways, including through the use of appropriate interfaces, to connect digitally with them to ensure that related customer requirements for rail transport processes are seamless and digitally enabled to the extent possible.

7. Digital rail business processes

39. For large organizations like railways, internal business processes need to be efficient in order to reduce the costs of operations and increase overall efficacy. Enterprise resource planning tools are widely used by such large organizations to manage internal business processes such as accounting, procurement, project management, risk management and compliance, and supply chains.

40. In the context of railways, internal business processes typically include the following:

(a) The management of employees: salaries, promotions and training;

(b) Financial management: the collection and accounting of freight and passenger revenue budgeting, capital and operations expenditure;

(c) The procurement of assets: wagons, locomotives and coaches, as well as spare parts;

(d) The procurement of services: housekeeping and maintenance contracts;

(e) Inventory management;

(f) The flow of information across internal business stakeholders.

Suggested action

41. Member railways are encouraged to adopt digital solutions to manage their internal business processes. They should share experiences, good practices and lessons learned when choosing appropriate digital solutions.

8. Digital rail border crossings

42. Increases in freight train services between Asia and Europe point to the emergence of sustainable rail transport connectivity between the two continents, providing an opportunity for member railways to participate in and benefit from the growth in international railway transport. However, as trains move from one continent to another, they have to cross a number of borders, which is why it is imperative to aim for simple and streamlined border crossing formalities. Only once this has been achieved will operations be reliable and trains punctual. One of the measures that can have a significant impact on rail border crossings is ensuring timely access to the information required to complete the formalities. The digital exchange of information among stakeholders can ensure that the information required by regulators, rail operators and other stakeholders is available in a timely manner.

43. The importance of exchanging information digitally has been recognized by member railways since the fifth meeting of the Working Group on the Trans-Asian Railway Network, held in Busan, Republic of Korea, on 14 and 15 June 2017. At its seventh meeting, held in Bangkok and online on 20 and 21 May 2021, the Working Group expressed its readiness to consider a new annex to the Intergovernmental Agreement on the Trans-Asian Railway Network containing general principles on electronic information exchange among railways and between railways and control agencies along the Network. The adoption of such an annex would pave the way for more projects and activities aimed at promoting the seamless electronic exchange of information among rail stakeholders. The potential of digital information exchange to streamline rail border crossing formalities has recently been underscored in a joint publication of ESCAP and the Organization for Cooperation between Railways.[3]

Suggested action

44. Regional cooperation in rail border crossing facilitation is important, as the actions of one member railway have an impact on other member railways. Simplifying, streamlining and harmonizing rail border crossing formalities can go a long way in enhancing the competitiveness of international railway transport and, in this regard, the digital exchange of information can play a pivotal role.

[3] Organization for Cooperation between Railways and ESCAP, *Digitalization: Next Step for Future International Railway Traffic* (Warsaw, 2022).

45. Member railways are encouraged to harmonize rail transit data sets to ensure the seamless electronic flow of information for the efficient completion of regulatory formalities and operational requirements for international train operations. They could simultaneously undertake pilot applications, for example on the use of electronic consignment notes on selected railway corridors. To reap the full benefit of electronic information exchange, member railways could contemplate adopting a digitally enabled regional transit regime for rail transport to support international railway transport from Asia to Europe and vice versa.

D. Key enablers

1. Enhancing the digital skills of rail officials by developing a regional capacity-building programme

46. Enhancing the digital skills of railway officials would play a key role in achieving the objective of the Strategy 2030. While there will be pressing need to train staff in the use of digital technologies, adopting a more comprehensive approach to such training would enable rail organizations to attract and retain digitally qualified and experienced talent. While some railway organizations in the region have made significant progress in upgrading the digital skills of their officials, most are still in the early stages of doing so.

47. Member railways will encounter multiple challenges as they aim to enhance the digital skills of their workforce, including resistance to change and lack of buy-in from staff. Some railway organizations may lack the resources needed to provide comprehensive digital skills training. There is also a skills gap between younger and older railway officials, with the former being generally more comfortable with digital technologies but having less decision-making authority.

48. A critical measure for enhancing capacity would be to encourage a cultural shift within railway organizations to foster the innovation required to develop and implement digital solutions. This might be even more challenging within the comparatively rigid organizational structure of many railway organizations in the region and would need supportive management with the willingness and ability to promote and carry out such a shift. Management would also need to adapt and adjust recruitment practices and structures to attract and train a digital workforce.

Suggested action

49. Capacity-building for rail digitalization would require action at many levels. At the national level, comprehensive efforts should be made to develop curricula and foster a research environment that supports the development of rail digital skills and encourages innovation. Member railways should also consider establishing dedicated programmes, core groups and centres of excellence to enhance the rail digital skills of their personnel.

50. At the regional level, the capacity-building initiatives of member railways could be supported through the development of a regional capacity-building programme involving a pool of experts on rail digitalization. ESCAP could consider managing such a pool of experts to augment the capacity of its members on rail digitalization and innovation.

2. Increasing investment in rail digitalization by setting up a rail digital and innovation fund

51. Financing for rail digitalization generally comes from government budgets even in developed countries. Germany, for example, is spending 500 million euros to accelerate rail digitalization. In developing countries, however, government budgets are always under pressure owing to other pressing needs; rail infrastructure is rarely a priority. It is therefore imperative to explore other innovative sources of financing, particularly to support rail digitalization in the least developed countries and landlocked developing countries in the Asia-Pacific region.

52. Owing to the extensive scale of their operations, larger railway organizations have more opportunities to find non-traditional sources of funding, for example data monetization. Given concerns about data privacy and the existing data protection laws, this has to be approached carefully. Another way to reduce the financing requirements for rail digitalization is to consider the use of private, public or hybrid cloud-based servers, which would obviate the need for expensive in-house data centres that require considerable capital investment and operational expenses. The involvement of startups, which can develop innovative rail digital solutions, should be explored wherever possible through mutually beneficial partnerships with rail companies.

53. It is a fact that greater rail digitalization would entail more financial investments in digital infrastructure, research and innovation, and digital skills. Regional cooperation can play a significant role in financing rail digitalization. The European Union, for example, provided financial

support for rail digitalization through Horizon 2020, its programme for funding research and development, which allocated some 13 billion euros to railways.[4]

54. A dedicated source of funding for the region such as a multi-donor rail digital innovation fund could support the least developed countries and landlocked developing countries to leapfrog digital curves and adopt emerging and future technologies in a more cost-effective manner. Such a financing source could potentially attract private-sector entities with a commercial interest in investing in rail digitalization projects and initiatives.

Suggested action

55. To give the desired focus and momentum to rail digitalization in Asia and the Pacific, a region-specific funding modality focusing on rail innovation and digitalization is needed. Member railways may consider setting up a rail digital and innovation fund to accelerate rail digital transformation in the region. Such a fund would promote the adoption of rail digital technologies based on the priority needs of the member railways in the region. Drawing upon international experiences, such a fund could be conceived as multi-donor fund, with oversight provided by a committee consisting of representatives of member railways. Such a fund could provide catalytic funding to high-potential rail digital projects, particularly to support the least developed countries and landlocked developing countries in the region so as to enable them to leapfrog to digital rail.

3. Strengthening rail cybersecurity, including data protection, by developing a regional framework on rail cybersecurity

56. With the digitalization of rail comes the importance of rail cybersecurity. While many countries in the region have established supporting policies and implementation frameworks at the national level, most do not explicitly consider critical national infrastructure such as rail. The development of related norms is left to the rail operators and supply chain participants, who may lack the expertise to strengthen resilience against cybersecurity risks more broadly. Moreover, while the importance of safety is well-established in the rail sector, the impact of cybersecurity

[4] See https://rail.nridigital.com/future_rail_jun19/a_bold_shift_but_how_to_fund_it_five_takeaways_from_the_eu_s_rail_digitalisation_report.

on rail safety in the digital environment is yet to be recognized and understood in most countries.

57. In addition, managing rail cybersecurity risk requires significant domain knowledge and expertise that needs to be cultivated over time. The capacity of railway officials needs to be constantly developed and a pool of experts who can understand evolving cybersecurity risks and find ways to address them needs to be established at the regional level. Presently, rail cybersecurity is understood and implemented differently by the members of the Trans-Asian Railway Network. When each member railway organization either proactively or reactively develops cybersecurity guidance, the potential benefits that could accrue from regional cooperation on this vital issue remain unexplored.

58. Forming collaborative international relationships among member railways can have significant benefits for rail cybersecurity in the region. Good practices, threat intelligence and solutions can be shared. Cooperative arrangements can be formalized among States to promote the development of a cybersecurity culture wherein information is shared to the mutual benefit of all partners (for example, information shared by one State may lead to action that prevents an incident that could affect other States).

59. Cybersecurity measures in the rail sector can take different forms, from organizational policies[5] to industry-led strategies.[6] Directive (EU) 2022/2555 of the European Parliament and of the Council of 14 December 2022 on measures for a high common level of cybersecurity across the Union has as its core objective to improve cybersecurity across the States members of the European Union. It provides a framework centred on three key areas: developing and maintaining a national capability for incident response and testing cybersecurity response; promoting collaboration and information-sharing across member States; and focusing on the cybersecurity of critical national infrastructure.

60. Standards have been developed, for example the CLC/TS 50701 of the European Committee for Electrotechnical Standardization, which focuses on rail cybersecurity throughout the whole lifecycle of assets, as well as guidelines for cybersecurity in railways, such as those of the International Union of Railways. Notwithstanding these initiatives, rail cybersecurity in the region needs to consider other challenges, such as

[5] See, for example, Indian Railways and the Singapore metro.

[6] See, for example, the *Rail Cyber Security Strategy* in the United Kingdom of Great Britain and Northern Ireland Rail Delivery Group.

the longevity of rail assets, the involvement of diverse stakeholders, the management of legacy infrastructure and wider access to rail security critical assets.

Suggested action

61. Rail cybersecurity is an issue of considerable importance for successful rail digitalization. As some member railways are at an advanced stage of rail digitalization while others are just at the beginning, a staggered approach to rail cybersecurity should be adopted, preferably through a regional framework on rail cybersecurity that builds on work already done, lays common principles based on global good practices tailored to the specific requirements of the region, provides for information-sharing, identifies current and future skill sets, and encourages capacity-building and experience-sharing.

4. Using data analytics to support optimal decision-making by preparing an inventory of cost-effective solutions

62. Railway systems generate a huge volume of data on passengers, freight customers, train operations and the maintenance of assets. These data can be constructively used to improve railway services. Artificial intelligence capabilities in prediction, voice recognition, image processing and natural language processing can be game changers in improving the efficiency of railways and delivering desired services to valued customers. Artificial intelligence, machine learning, big data and the Internet of things are technologies that hold immense potential for significantly improving operations, maintenance, customers' experience and internal processes. By using data analytics, railways can enhance the efficiency of their operations and provide a better customer experience while reducing costs and improving safety. Big data analytics can help predict maintenance needs by processing information collected through sensors on wear and tear, usage patterns and weather conditions, for example, thereby reducing downtime, improving safety, optimizing maintenance schedules, and reducing costs. Similarly, analytics can support network efficiency by optimizing the use of routes, paths, rolling stocks and crews. This can help to identify bottlenecks, improve infrastructure, operations and reliability, and reduce operational costs.

63. In addition, by analysing historical data on ticket sales, travel patterns and demographic trends, policymakers can make informed decisions about service levels, route planning and pricing strategies with the aim of enriching the customer experience. Analytics can support complaint management systems, chatbots and interactive voice response

systems and provide real-time train running information, further enhancing the customer experience. Big data analytics can also help to identify potential risks to railway operations and infrastructure, as well as to passengers, by analysing data from sensors, cameras, and other sources. It can also help to identify patterns of behaviour that may indicate security risks.

Suggested action

64. Few member railways are at an advanced stage and have been harnessing the advantages of big data analytics and related technologies for many aspects of rail. Many least developed countries and landlocked developing countries in the region face challenges in being able to use data analytics and related technologies in rail owing to limitations in data availability due to the lack of supportive rail infrastructure, as well as capacity and resource constraints in running expensive data analytics platforms. Experience has shown that railway organizations that effectively harness the potential of data analytics have support from top management, foster a collaborative working environment and promote analytics across the organization. Regional cooperation can help to overcome challenges related to data analytics through the sharing of knowledge, resources, and expertise, as well as through the provision of access to funding, technical support and capacity-building. A regional inventory of cost-effective solutions on rail data analytics should be prepared and used for reference, as appropriate, by railway policymakers.

5. Heightening engagement with the private sector by putting in place a supportive legal and regulatory framework

65. Harnessing the full potential of rail digitalization requires fostering an ecosystem of railways with original equipment manufacturers, information technology companies and other government agencies. Increasing engagement with the private sector would be beneficial because it reduces overall costs and creates new revenue streams. In particular, the data created through digitalization becomes an asset that private companies can use to build solutions.

66. Furthermore, the data can enable the emergence of entirely new markets that add robustness and financial viability to the railway ecosystem. For example, the railway sector in the United Kingdom of Great Britain and Northern Ireland has made available data – on performance, routes, timetables, real-time traffic updates, network disruptions and ticketing – thus allowing private companies to use the data to create a plethora of applications and products and to provide

services for users that range from ticket-selling to the gamification of commuting trips.[7]

67. Companies can benefit from the virtual currency of digital data both as a revenue stream and as an avenue to improve customers' experiences by offering more services. That said, reaping the almost infinite value of digital data requires well-managed policies to process, collect, store, manage, secure, and distribute digital data and appropriate legal and regulatory frameworks to ensure the appropriate use of data. Private companies could also be encouraged to use customer-centred digital rail applications as marketing platforms. Railways could invite private entities to develop applications for selling naming rights. The Dubai Metro, Transport for London and the Metropolitan Transportation Authority of New York have all been involved in initiatives where private companies have sponsored several projects in exchange for branding and naming rights.

Suggested action

68. Railway policymakers need to formulate and implement proactive policies that encourage the participation of private players in rail digitalization. They need to put in place supportive legal and regulatory framework to ensure the appropriate use of digital data to generate revenue and improve the customer experience. Clear policies in this regard would encourage private entities to participate in the development of value-added applications and enrich customers' experience. In addition, at the regional level, a rail digital and innovation forum could be conceived as a platform for private entities to interface with rail policymakers.

E. Implementing and monitoring

1. Developing implementation arrangements

69. Member railways may develop an action plan for implementing the Strategy 2030 at the regional level. In addition, given that each subregion of ESCAP faces unique challenges with respect to rail digitalization, subregional action plans could be contemplated. To accelerate the digital transformation of rail, an appropriate modality needs to be developed at the national level, either as a stand-alone component or as part of a comprehensive railway master plan. Such a modality would help to take

[7] Jemima Kiss, "Chromaroma and the onward march of gameification", *The Guardian*, 4 December 2010.

stock of current initiatives, identify priorities and gaps, and develop actions plans to accelerate rail digitalization. It should interface appropriately with the Strategy 2030 to take advantage of the benefits of regional cooperation for rail digitalization. National-level strategies should lead to more tangible action by directing priorities and investments towards long-term goals while remaining aligned to regional frameworks.

70. Furthermore, based on the experiences of successful railways, a dedicated organization could be set up within railways to lead rail digitalization initiatives. Such an organization could focus on rail digitalization projects and work with external partners, including private entities, pilot rail digital solutions to establish their feasibility, develop capacity-building opportunities for railway personnel, identify the legal and regulatory changes required to support rail digitalization and take other measures to foster an environment conducive to rail digitalization.

2. Measuring progress in rail digitalization through a rail digital index

71. To measure progress in rail digitalization in the member railways of the region, a rail digital index could be developed. Based on the issues identified in the Strategy 2030, key performance indicators could be identified and, keeping in mind the availability of data, an index could be developed to measure the progress made by each member railway towards digitalization. The index could also be used to measure progress in the country, to identify areas requiring policy intervention, to set measurable targets in key performance areas and to encourage action.

72. However, rail digitalization is a process of continuous transformation that could be unquantifiable and not exhaustive. The presence or absence of certain capabilities is not necessarily an accurate indication of the progress that has been made in rail digitalization. Therefore, a more generic complementary measure of performance should also be developed. Its aim will be to group railways of the region by three levels of maturity as indicated below.

73. Railways in maturity level 1 have the following: for passenger transport, manual booking of physical tickets at stations, manual checks and analogic service information; and, for freight transport, fixed service tariffs with paper-based booking, zero-to-limited tracking at certain stations, zero-to-limited multi-operator booking and manual checks at borders. Railways in level 2 have the following: for passenger transport, online or digital kiosk booking, manual checks and digital service information at stations; and, for freight transport, fixed service tariffs with

online booking, tracking at points along the route, some multi-operator booking, digital certificates and manual checks. Railways in level 3 have the following: for passenger transport, mobile and digital ticketing, automated ticket barriers and real-time mobile application service information; and, for freight transport, mobile and digital bookings with real-time pricing and tracking of cargo, multi-operator booking across countries, digital certificates and checks at borders.

74. Concurrently, it is also important to look at rail digitalization from a wider perspective, taking into consideration the reasons behind digitalization initiatives. The main aims of rail digitalization are to improve efficiency, service, and connectivity and to reduce costs. Therefore, while tracking the deployment of rail digital technologies, it is also important to measure whether those technologies are rendering the desired results.

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