UNECE

Handbook on Digitalization and Automation in Intermodal Freight Transport

UNITED NATIONS

UNITED NATIONS ECONOMIC COMMISSION FOR EUROPE

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UNITED NATIONS ECONOMIC COMMISSION FOR EUROPE

The United Nations Economic Commission for Europe (UNECE) is one of the five United Nations regional commissions, administered by the Economic and Social Council (ECOSOC). It was established in 1947 with the mandate to help rebuild post-war Europe, develop economic activity and strengthen economic relations among European countries, and between Europe and the rest of the world. During the Cold War, UNECE served as a unique forum for economic dialogue and cooperation between East and West. Despite the complexity of this period, significant achievements were made, with consensus reached on numerous harmonization and standardization agreements.

In the post-Cold War era, UNECE acquired not only many new member States, but also new functions. Since the early 1990s the organization has focused on assisting the countries of Central and Eastern Europe, Caucasus and Central Asia with their transition process and their integration into the global economy.

Today, UNECE supports its 56 member States in Europe, Caucasus, Central Asia and North America in the implementation of the 2030 Agenda for Sustainable Development and its Sustainable Development Goals (SDGs). UNECE provides a multilateral platform for policy dialogue, the development of international legal instruments, norms and standards, the exchange of best practices and economic and technical expertise, as well as technical cooperation for countries with economies in transition.

The norms, standards and conventions developed at UNECE in the areas of environment, transport, trade, statistics, energy, forestry, housing and land management, innovation or population, offer practical tools to improve people's daily lives. Many are used worldwide, and a number of countries from outside the region participate in work of UNECE.

UNECE's multisectoral approach helps countries to tackle the interconnected challenges of sustainable development in an integrated manner, with a transboundary focus that helps devise solutions to shared challenges. With its unique convening power, UNECE fosters cooperation among all stakeholders at the country and regional levels.

TRANSPORT IN THE ECONOMIC COMMISSION FOR EUROPE

Today, UNECE services 60 United Nations inland transport legal instruments. Several of the legal instruments are global either by design or because their success has caused them to grow beyond the ECE region. In addition to negotiating the amendments to existing legal instruments, UNECE has been active in facilitating new legal instruments. Its normative activities are enhanced with developing methodologies, guidelines, and definitions on subjects such as transport planning, data collection and the collection of transport statistics. UNECE's work on transport is governed by the Inland Transport Committee (ITC) and its 21 Working Parties, which are in turn supported by more than 40 formal and informal expert groups and in cooperation with 11 treaty bodies (Administrative Committees). Annual sessions of ITC are the key moments of this comprehensive intergovernmental work, when the results from all subsidiary bodies, as well as the UNECE Sustainable Transport Division, are presented to ITC members and contracting parties.

In addition to servicing ITC and its subsidiary bodies, the Division also services other intergovernmental bodies including the ECOSOC Committee of Experts on the Transport of Dangerous Goods and on the Globally Harmonized System of Classification and Labelling of Chemicals, as well as 11 treaty bodies of United Nations legal instruments and the TIR Executive Board. In cooperation with United Nations Economic and Social Commission for Asia and the Pacific (UNESCAP), UNECE Sustainable Transport Division supports the United Nations Special Programme for the Economies of Central Asia (SPECA). It also annually alternates with UNESCAP as the secretariat to the SPECA Thematic Working Group on Sustainable Transport, Transit and Connectivity. In cooperation with the UNECE Environment Division and World Health Organization for Europe, the Division services the Transport, Health and Environment Pan-European Programme (THE PEP). It ensures the management and oversight of the Trans-European North-South Motorway (TEM) and the Trans-European Railway (TER) projects. The Division supports the accession to and implementation of the UN legal instruments through policy dialogues, technical assistance, and analytical activities with the priority of promoting regional and subregional cooperation and capacity-building. Finally, since 2015, UNECE hosts the secretariat of the United Nations Secretary-General's Special Envoy for Road Safety and since 2018 the secretariat of the United Nations Road Safety Fund (UNRSF).

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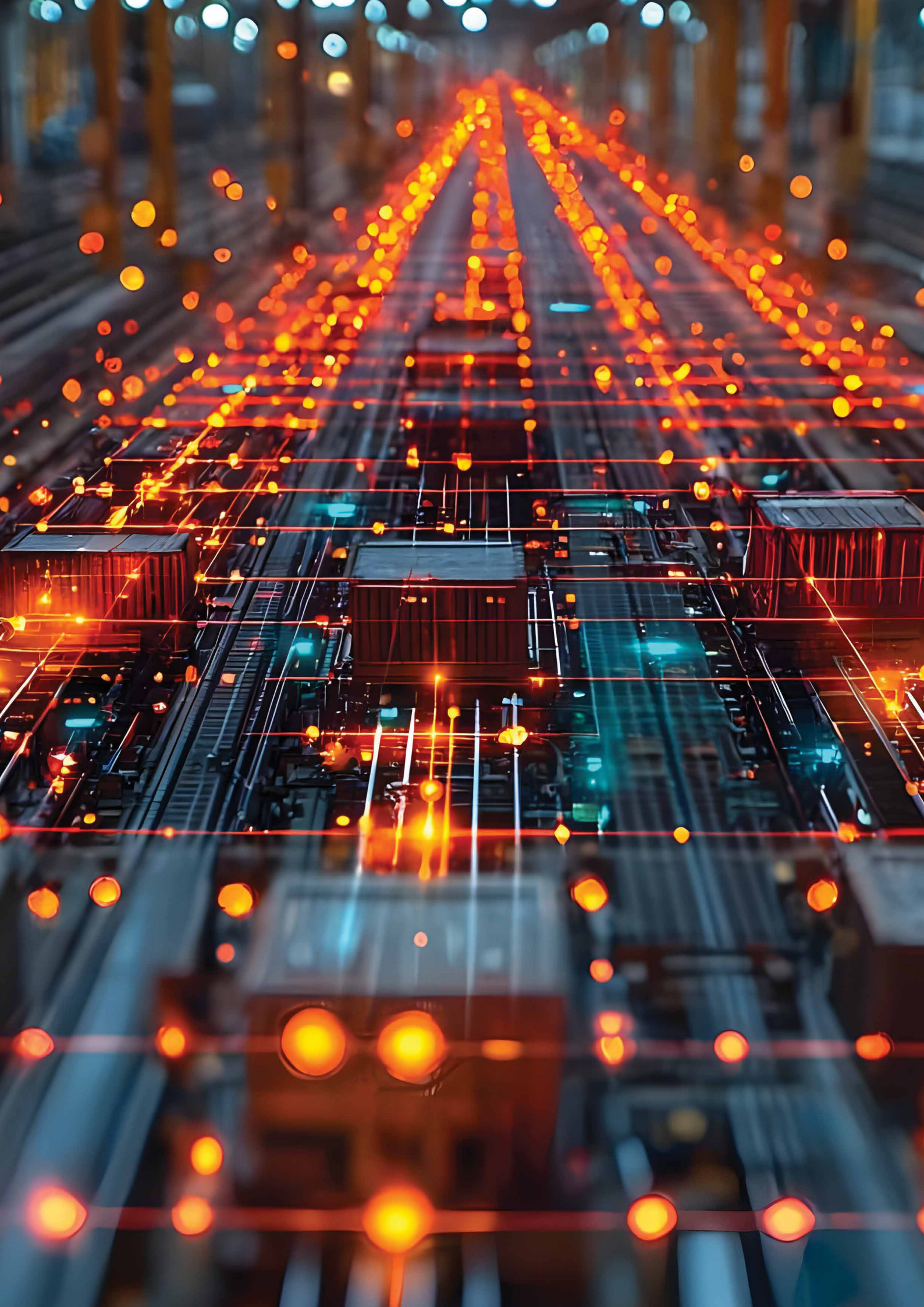
Despite the environmental benefits of intermodal transport, where railways serve as the main mode, road transport remains the dominant choice for freight in many regions. This underutilization of intermodal options can be attributed to factors such as the often longer delivery times, reliance on traditional paper-based information systems in some areas, and the absence of interoperable digital standards.

Technological advancements present opportunities to address these challenges. Digitalization in freight transport could transform traditional analogue information and processes into digital formats, enabling streamlined information exchange. With this digital foundation, many processes in intermodal transport can be automated, and when managed correctly, digitalization and automation can enhance the reliability, efficiency, and cost-effectiveness of intermodal transport.

However, cybersecurity remains a significant concern, as potential cyber threats could disrupt operations or compromise sensitive data. Ensuring cybersecurity is essential for system stability and business continuity, thereby supporting the resilience of digitalized intermodal freight systems. Additionally, it is important to ensure that digitalized information is interoperable across systems for a seamless and efficient transport chain. Last but not least, a human-centric approach to digitalization and automation is vital to ensure that the benefits of technological advancements are shared equitably among stakeholders and that support is provided for those adversely affected.

This handbook offers guidance and a starting point for stakeholders interested in digitalizing and automating intermodal transport, highlighting the benefits of improved efficiency, safety, and job quality, as well as the importance of a human-centric approach in implementing these changes.



I. INTRODUCTION

Multimodal transport, intermodal transport, and combined transport all refer to the movement of goods using two or more modes of transport. While multimodal transport could be understood as the simplest overarching term for transport of goods using two or more modes of transport, intermodal freight transport refers more specifically to the transport of goods in one and the same loading unit or road vehicle successively in two or more modes of transport, without handling the goods in changing modes.[1] Combined transport is a subset of intermodal transport, where the major part of the European journey is by rail, inland waterways, or sea, and any initial and/or final legs by road are as short as possible.[2]

Intermodal transport is recognized as one of the most sustainable and economically sound ways to carry goods, particularly on distances over 500 km. Despite its benefits in lowering carbon emissions of transport, road transport continues to be the dominant mode of transport in many parts of the world. According to Eurostat, road transport accounted for 77.8 per cent of total inland freight transport in the European Union in 2022, while the share of railway and inland waterways only accounted for 17.1 and 5.1 per cent respectively.[3]

The underutilization of intermodal freight transport could be attributed to several factors, one of which is often longer delivery time due to handling procedures at intermodal terminals. By nature, intermodal freight transport's effectiveness relies heavily on the seamless coordination amongst various stakeholders and components, demanding efficient information flow throughout the journey. Traditional paper-based exchange of information and documents still prevails in many countries. Although a considerable amount of information and data necessary for intermodal freight transport is being digitized, it often remains localized within individual enterprises or at a national, modal, or regional level. The lack of application of interoperable standards in data poses a significant challenge to the industry, resulting in additional processing time at various intermodal terminals. Without the application of these interoperable standards, the efficiency of intermodal freight transport is substantially restricted and this has a potential of becoming a serious issue in the future.

Another bottleneck in intermodal transport, especially for cross-border traffic, is the lack of a harmonized or unified legislative system for rail carriers. Rail companies have long been at a competitive disadvantage due to the absence of a uniform legislative system, unlike their counterparts in road transport (covered by the Convention on the Contract for the International Carriage of Goods by Road (CMR)), maritime transport (covered by the Hague-Visby Rules), and air transport (covered by the Montreal Convention). While the new Convention on the Contract for International Carriage of Goods by Rail (URL1) of the Economic Commission for Europe (ECE) may address this shortcoming by enabling, for the first time, rail carriage (and certain intermodal carriage) on long distance and intercontinental routes under one legal system with one contract of carriage stipulated in one consignment note, the competitive advantage would come to rail and intermodal carriage from making the consignment note operational in a digital form.

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1 Adapted from definition of intermodal transport according to ECE, Terminology on combined transport, New York and Geneva 2001.

2 See EU Directive 92/106/EC for the definition of Combined Transport in the European Union.

3 Eurostat, Modal split of inland freight transport, 15 April 2024.

With the rapid pace of technological advancement, opportunities also abound to streamline or automate many manual tasks within intermodal freight transport. Automated machinery has the potential to streamline operations and reduce reliance on manual processes, particularly for tasks that are unappealing due to their repetitive and/or physically demanding nature. For instance, automated coupling and decoupling of rail wagons could significantly reduce human efforts in the process.

A. PURPOSE OF THE HANDBOOK

This handbook seeks to provide a starting point for stakeholders wishing to digitalize and automate intermodal freight transport, including, but not limited to, national governments, transport operators, as well as cargo terminal operators. It covers the potential benefits of digitalization and automation if correctly managed, including enhanced efficiency and safety while reducing hardship and unappealing jobs, alongside the associated costs of digitalization and strategies for maintaining a human-centric approach when applying these new technologies.

B. OVERVIEW OF DIGITALIZATION AND AUTOMATION IN FREIGHT TRANSPORT

Digitalization refers to the process of converting information or processes into a digital format, with a view to digitalizing and improving business processes. It involves the adoption of digital technologies to transform traditional analogue or manual information and processes into digital ones. It often requires businesses to rethink and reengineer existing business processes to reap the full benefits of digitalization. Automation on the other hand, involves the use of technology to perform tasks or processes with reduced or minimal human intervention. It aims to streamline operations, increase efficiency, reduce hardship and human error by replacing manual actions with automated ones.

Digitalization often goes hand in hand with automation and is often referred to as the enabler and foundation framework for automation. It lays the foundation by transforming traditional paper-based processes into digital workflows, enabling communication and data exchange across diverse modes of transport.

Automation relies heavily on the availability of digitalized information to perform various automated processes and can be categorized into two distinct domains: the automation of information flows and the automation of physical tasks. Automating information flows relies heavily on interoperable digital infrastructure to handle processes such as automated documentation and scheduling optimization. On the other hand, automation of physical tasks, such as automated coupling and decoupling of trains and automated cargo terminals often require physical infrastructure, ranging from internet-of-things enabled sensors to automated cranes, for instance. Both types of automation depend on robust digitalization to function effectively but address fundamentally different aspects of freight operations.

In addition to interoperability, cybersecurity is another main barrier for digitalization in freight transport. In a survey conducted by the International Union of Railways (UIC) in 2022,[4] cybersecurity was ranked with the highest consensus as the most important domain in intermodal transport by intermodal transport operators. Marketers could exploit private, sensitive digital information such as recipient data and order details, or maliciously disrupt train traffic. However, cybersecurity should be considered beyond the narrow confines of preventing cyberattacks. It should also include maintaining system stability and be capable of performing contingency plans to ensure business continuity and basic functionality in the event of a disruption.

C. OVERVIEW OF THE LEVEL OF DIGITALIZATION AND AUTOMATION IN DIFFERENT COUNTRIES AND ECONOMIES

While there is no readily available information on the level of digitalization and automation for each country in freight transport and logistics, the World Bank's Logistics Performance Index (LPI), or rather its specific components, can provide some insights and serve as a proxy for estimating the level of digitalization/automation. To recall, the LPI, published biennially by the World Bank, is a benchmarking tool designed to help countries identify challenges and opportunities in their trade logistics performance. It consists of six components: customs, infrastructure, international shipment, logistics competence and quality, timeliness, and tracking and tracing scores.

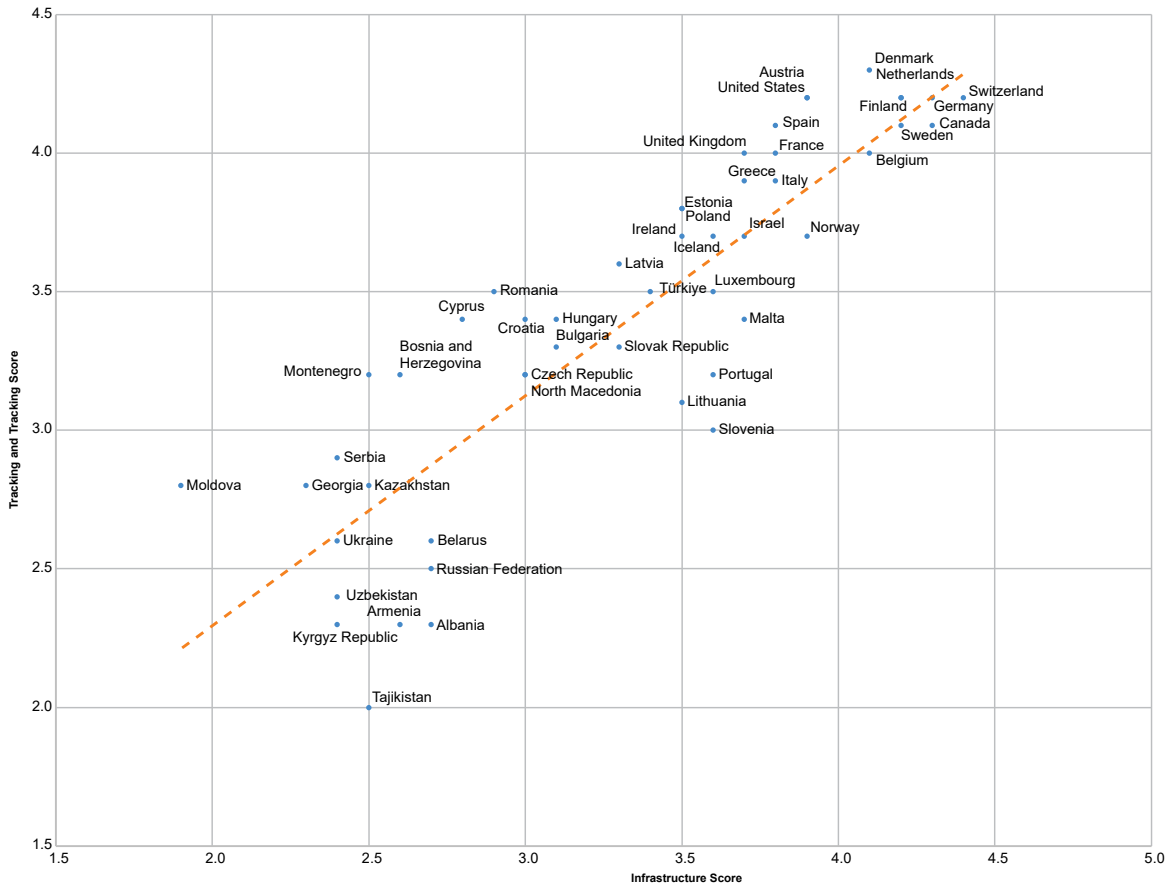
While digitalization and automation would affect scoring across all six components, infrastructure, specifically digital infrastructure, and tracking and tracing are of particular relevance. A robust logistics infrastructure often incorporates advanced technologies and automated systems.[5] Additionally, the ability to track and trace shipments in real-time is a direct result of digitalization and automation in logistics. This reflects the integration of Internet-of-Things (IoT), global navigation satellite system (GNSS), and other digital technologies.

As shown in figure I below, there is a strong correlation between the infrastructure score and the tracking and tracing score in the LPI in 2023. Notably, countries which top the tracking and tracing score also tend to excel in the infrastructure score. For example, Singapore, which ranked first, and Switzerland, Germany and the Netherlands, which ranked joint third in the tracking and tracing component, were ranked first, second, third and fifth respectively in the infrastructure component.

[4] UIC, 2022 Report on Combined Transport in Europe, January 2023.

[5] The LPI survey does not specifically categorize the types of technologies in infrastructure scoring, but these technologies are indirectly reflected in the dwell times experienced by shippers in various countries. Shippers' expectations for modern infrastructure, including automated cargo handling and recording, could also be reasonably assumed to contribute to the overall assessment of infrastructure quality.

Figure I
Correlation of LPI tracking & tracing score and infrastructure score in selected ECE member States



II. MAKING A BUSINESS CASE

A. BENEFITS OF DIGITALIZATION AND AUTOMATION

In an ever-evolving landscape of global trade and logistics, the integration of digitalization and automation has the potential to reshape the ways in which goods are transported across various modes of transport. Intermodal freight transport, which combines multiple modes such as rail, road, inland waterway etc., stands to benefit from these advancements. Digitalization and automation in intermodal freight operations, if correctly managed, can offer a multitude of advantages, starting with enhanced multimodal transport reliability, which will in turn lead to improved efficiency and cost-effectiveness. Other benefits involve improved safety and sustainability.

This section explores in detail the benefits of digitalization and automation within intermodal freight transport, highlighting their potential to improve operating efficiency, facilitate modal shift, reduce manual efforts, hardship, and unappealing jobs, and thereby improving global competitiveness in general. Details of the various technologies which may be used to achieve these benefits are discussed in section IV.

1. IMPROVING OPERATING EFFICIENCY

With the adoption of technologies like IoT, artificial intelligence (AI), blockchain, process automation and digital twins, stakeholders in the logistics sector have the potential to streamline traditional practices and realize substantial improvements in time and cost savings. For instance, process automation can significantly reduce manual efforts in processing and preparing information, including the completion of necessary digital documents for freight transport. These digital documents and information would allow the information to be retrieved and exchanged more efficiently. By deploying IoT-enabled devices and sensors within cargo containers and transportation assets, one could further automate the verification of transport documents, enhance real-time tracking and monitoring capabilities, and enable operators to more precisely manage routing, minimize idle time at terminals, mitigate potential disruptions, as well as assist advance ruling by regulatory authorities (e.g., customs). Furthermore, AI-driven predictive analytics algorithms could assist in forecasting demand through analysis of big data, optimizing resource allocation, and streamlining scheduling processes. These could all translate into savings in turnaround times and improving asset utilization, making intermodal freight transport more competitive even at shorter distance transport.

Additionally, blockchain technology may ensure transparent and secure data sharing, facilitating seamless collaboration among different stakeholders and minimizing administrative overhead. These innovative technologies, if managed correctly, could help intermodal freight operators to achieve efficiency gains, thus enhancing their competitiveness in the global market.

2. FACILITATING MODAL SHIFT

Digitalization and automation would also serve as catalysts for facilitating modal shift within the freight transport industry by lowering the costs of transport while improving the delivery time of consignments. By leveraging advanced technologies such as data analytics and optimization algorithms, stakeholders could identify opportunities for transitioning freight to rail, waterways, and other more sustainable transport modes. These technologies could also provide opportunities to implement real-time monitoring of freight movements, allowing for more dynamic routing and scheduling decisions, making intermodal freight transport more competitive. Moreover, digital platforms and standardized data exchange protocols could also improve and harmonize intermodal connectivity across different carriers, streamlining the transhipment process and reducing handling costs and transit times, all of which could encourage shift towards intermodal transport.

Another key potential benefits of digitalization and automation is the ease of reaching customers through digital platforms and marketplaces. By leveraging digital technologies, logistics providers can establish online platforms where customers can easily access and book intermodal services. These platforms could provide customers with greater visibility into available services, pricing options, and transit times, enabling them to make informed decisions and manage their logistics needs more efficiently.

3. IMPROVING OCCUPATIONAL HEALTH AND SAFETY

Digitalization and automation in intermodal freight transport could not only enhance operational efficiency but also improve occupational health and safety. Traditionally, freight logistics has been characterized by labour-intensive processes, requiring substantial manual intervention and often exposing workers to challenging and hazardous conditions. However, with the advent of automation technologies such as robotic handling systems, many physically demanding tasks can be performed more efficiently and safely. Automation could reduce the need for manual labour in tasks like loading and unloading cargo, which not only minimizes the risk of workplace injuries but also improves overall productivity. Moreover, digitalization may also streamline administrative tasks, reducing the burden of paperwork and manual data entry for workers. This could potentially enhance job satisfaction, promote safer working environments, and contribute to a more appealing and sustainable workforce in the intermodal freight industry. However, realising these benefits requires deliberate efforts to ensure that workers are supported through training and upskilling programmes. This proactive approach enables workers to transition into roles that focus on more strategic and value-added tasks, fostering a more skilled and engaged workforce capable of driving innovation and growth within the sector.

B. CHALLENGES OF DIGITALIZATION AND AUTOMATION

Despite the many benefits brought about by digitalization and automation, there are challenges that hinder their adoption, impacting the industry's efficiency, reliability, and security. Among these challenges are the lack of interoperable standards, the need to re-engineer established business processes, substantial initial setup costs, and growing concerns surrounding cybersecurity. Addressing these issues is crucial for realizing the full potential of technological advancements in intermodal logistics.

1. INTEROPERABILITY STANDARDS

The lack of interoperability stands as a significant obstacle in the path toward fully integrating digital technologies across different modes of transport. Without standardized protocols and interfaces for data exchange, and a common semantic reference base, interoperability between various systems and platforms becomes difficult to achieve, leading to inefficiencies, data silos, and fragmented operations. The absence of interoperable standards not only impedes seamless communication and collaboration among stakeholders but also hampers the scalability and flexibility of digital solutions within the intermodal freight ecosystem. The fragmentation of legal regimes and digitalization projects; modal, corporate, national, and regional solutions; as well as syntaxes are a problem in the making.

Another related challenge with interoperability standards is establishing trust among the various stakeholders involved. In a highly interconnected supply chain, various actors are often reluctant to share sensitive data due to concerns about how it could be used or misused. To address this issue, a robust, trustworthy, open-source, open standard framework that provides clear guidelines on data ownership, usage, and security is crucial. Such a framework should ensure transparency and security in data exchange, helping to build confidence among stakeholders and facilitate greater collaboration.

Box I
The UN/CEFACT package of standards for multimodal data and document exchange

A UN/CEFACT package of standards for the digitalization of multimodal cargo information exchange offers a comprehensive suite of deliverables for seamless electronic multimodal data and document exchange. It includes a common business requirement specification (BRS) customized for documents accompanying goods carried by different modes of transport, as well as supporting deliverables. These are based on common UN/CEFACT naming rules and definitions, terminologies, and structured data models, crucial for data exchange standards across multimodal supply chains. These ensure seamless communication, interoperability, and efficiency, enhancing digitalization in trade and transport corridors and global trade operations. The package of standards is meant to address the main problem of fragmentation of digitalization efforts and projects, national, regional and modal legal regimes, and various syntaxes.

The digitalization of trade and transport data and document exchange relies on UN/CEFACT robust data standards, critical for initiatives in such areas as trade finance (e.g., electronic Bill of Lading (eBL)), Single Window systems, and European Union's Electronic Freight Transport Information Regulation (eFTI) and other regulations. Future efforts, such as ECE recommendations on smart connectivity, will leverage these standards to further advance global trade networks.

In summary, adopting UN/CEFACT data exchange standards enhances global trade efficiency, fosters international cooperation, and strengthens supply chain resilience and sustainability in an interconnected world.

Pilot projects for the implementation of the UN/CEFACT package of standards, building on the understanding of fragmented digitalization projects and solutions, along increasingly multimodal trade and transport corridors and cross-border supply chains, create a new problem. Experience shows that this problem cannot be addressed through the imposition of a multimodal trade and transport document to accompany goods in transit. Rather, the answer to the problem should focus on data mapping and applying interoperable standards between modes, documents and sectors in the supply chain in a world where information about cargo is increasingly exchanged in the form of datasets (electronic records) rather than traditional documents, be they paper or electronic.

Source: United Nations Centre for Trade Facilitation and Electronic Business (UN/CEFACT). UN/CEFACT Package of Standards for data exchange along the supply chain, Document ECE/TRADE/C/CEFACT/2024/INF.2, Thirtieth session of the UN/CEFACT Plenary, 11 July 2024. Online: https://unece.org/sites/default/files/2024-07/ECE-TRADE-C-CEFACT-2024-INF-02E.pdf.

2. INITIAL SETUP COSTS

The upfront costs associated with implementing digitalization and automation initiatives may pose a substantial barrier for many companies in the freight transport industry. From investing in hardware and software infrastructure to training personnel and adapting workflows, the initial setup costs can be prohibitive, particularly for smaller players and companies operating on tight budgets. Despite the long-term benefits in terms of the potential efficiency gains and cost savings, navigating the financial challenges of digital transformation remains a daunting task. It may also be worth noting that the initial setup costs, particularly on the physical infrastructure which is often costly, may not make commercial sense and such investment should be made with due consideration to the potential return on investment. At the same time, it is worth noting that these costs may be relatively small when compared with investment that would be needed to overcome fragmented digitalization projects in the future.

In addition, the distribution of costs and benefits among different stakeholders should be considered. Balancing these factors across different players in the supply chain remains a significant challenge. In principle, costs borne by a market player should be proportionate to its potential gain from the investment. However, achieving this balance is often easier said than done. Due consideration of these should therefore be made from the outset of the project.

3. CYBERSECURITY

In addition to interoperability and setup costs, cybersecurity emerges as a pressing concern in an increasingly digitized and interconnected supply chain environment. As reliance on digital technologies grows, so does the risk of cyber threats such as data breaches, ransomware attacks, and supply chain disruptions. Safeguarding sensitive information, ensuring data integrity, and protecting critical infrastructure from cyber threats become paramount, requiring robust cybersecurity measures, proactive risk management strategies, and continuous vigilance across the intermodal freight ecosystem.

Furthermore, the risk of concentration of data should not be undermined. Data concentration under one single or a few entities could give rise to monopolistic practices, raising concerns that may deter efforts toward full interoperability. Addressing these challenges requires concerted efforts from industry stakeholders, policymakers, and technology providers to develop and implement comprehensive solutions and governance that prevent monopolistic practices, foster interoperability, mitigate setup costs, and enhance cybersecurity resilience in intermodal freight transport.

III. THE ROLE OF GOVERNMENTS

Governments play a crucial role in fostering the digitalization and automation of intermodal freight transport, shaping policies and frameworks that drive innovation while addressing potential challenges and risks. As the global economy increasingly relies on efficient logistics and transport networks, creating an environment conducive to technological advancements that enhance the productivity, sustainability, safety, and security of freight operations and their workers is crucial. This entails a multifaceted approach encompassing regulatory frameworks, investment incentives, infrastructure development, and collaboration with industry stakeholders and workers to harness the benefits of digitalization and automation while mitigating risks and ensuring equitable outcomes.

In facilitating digitalization and automation in freight transport, governments often act as catalysts for innovation by setting standards and regulations that promote interoperability and compatibility across systems. They establish guidelines for data sharing, cybersecurity, and privacy protection to facilitate seamless integration of digital technologies into supply chain operations. Furthermore, governments leverage funding mechanisms and incentives to encourage private sector investment in research and development, pilot projects, and deployment of digital and automated solutions. By fostering collaboration between industry players, academia, and research institutions, governments can accelerate the adoption of emerging technologies and drive transformative changes in freight transport systems for the benefit of society and the economy.

In the transition to digitalization and automation, governments also play a pivotal role in ensuring a human-centric approach that prioritizes the well-being and empowerment of individuals amidst technological advancements. Recognizing that technology should serve as a tool to augment human capabilities rather than replace them, governments should ensure that the human element remains at the forefront of this process. This includes implementing policies to facilitate continuous development, equipping workers with the necessary competencies and skills to adapt to the advancement in technologies, and ensuring that workers are involved and fairly represented in decision-making, with due consideration to the social protection required for those who are inevitably affected.

A. INTEROPERABILITY STANDARDS AND CYBERSECURITY

Government intervention and regulations are required to ensure safe, secure, and efficient operations in the freight transport and logistics industry. This includes setting institutional/legislative framework for, inter alia, interoperability standards, cybersecurity, and data protection in the industry to ensure seamless communication and coordination between various systems and stakeholders.

The arrival of automation and digitalization introduces new risks, in particular cybersecurity threats. It is important for the government to establish legislative framework and guidelines on best practices to mitigate these risks, ensuring that the technologies and practices adopted in the industry meet the necessary safety and security standards.

B. HUMAN-CENTRIC APPROACH

Governments should make every effort to ensure that the benefits of modernization and rationalization are shared fairly among all stakeholders – including the workers – as well as to ensure that any hardships to the workers that could result from such technological modernization and rationalization are mitigated by the adoption of appropriate social security and labour protection policies, accompanied by skilling and training programmes.

Owing to the importance of transport and logistics in society and the nature of the problems and challenges facing these services, governments have a major role to play in:

- Promoting the long-term success of automation and restructuring plans, and
- Easing the labour adjustment process resulting from such plans, while
- Fostering healthy labour-management relations, and
- Supporting the training of experts to roll out digitalization projects in the use of United Nations semantic standards, reference data models and legal instruments, and
- Improving the safety and overall conditions of all jobs.

1. PLANNING FOR AUTOMATION AND IMPROVEMENT OF TRANSPORT SYSTEM PERFORMANCE

Automation may help achieve sustainable gains in competitiveness while improving performance, quality of service, job security and working conditions. To fulfil these objectives, governments should encourage communication and consultation between intermodal transport and logistics employers, their associations, and workers' organizations on any potential automation and restructuring plans. They should also consider the following aspects in the transition towards digitalization and automation in intermodal freight transport:

- Integrated policies that take into account multi-disciplinary aspects including transport, energy and environment and land use in the promotion of intermodal transport and automation;
- Financing of digitalization and automation technologies;
- Level-playing field between various market players;
- Social costs and benefits of the new improvements (including labour adjustments and their external costs) and their fair distribution amongst the stakeholders;
- Needs for social protection, including monetary support and re-training needs, for those affected by the transition;
- Additional automation-related occupational safety and health standards and other applicable safety standards and means of monitoring compliance;
- Legislation and/or special collective bargaining mechanisms, as appropriate, to cope with labour adjustment problems that may result from digitalization and automation.

2. THE ROLE OF INSTITUTIONAL FRAMEWORKS TO ENSURE A HUMAN-CENTRED APPROACH

To promote the effective implementation of labour restructuring plans, governments have a role to play, wherever necessary, in establishing or revising an institutional framework that is adaptive to changing political priorities and including a mechanism for evaluating and revising policies and laws related to the automation and digitalization process. Below are aspects which governments may consider when establishing or revising such a framework to smoothen the labour adjustment process and promote healthy labour-management relations:

- Restructuring plans and their labour adjustment components resulting from a collective bargaining which takes into account the concerns of both the intermodal transport and logistics employers and workers' organizations;
- Pay structure considerations;
- Criteria and mechanism for worker separation settlements if these are an inevitable part of restructuring plans, so as to ensure fair and equitable treatment of the workers affected;
- Special job-placement and self-employment programmes that can explore, inter alia, opportunities for external redeployment of workers made redundant;
- Planning schemes for early retirement and separation schemes to enable timely payments;
- Applicable international labour standards concerning, in particular, freedom of association and collective bargaining and related nationally agreed standards.

The Organisation for Economic Co-operation and Development Principles for Private Sector Participation in Infrastructure (2007) emphasize in Principle 9 that "public authorities should ensure adequate consultation with end-users and other stakeholders including prior to the initiation of an infrastructure project.". Similarly, the International Labour Organization (ILO) advocate in its Conclusions No. 85 that "collective bargaining should be used to adapt working conditions to the structural and technological developments in transport."

Box II
What is social dialogue?

Social dialogue comes in various forms and levels according to national traditions and contexts, including in the form of cross-border social dialogue in an increasingly complex globalized economy. There is no one-size-fits-all approach to organize and strengthen social dialogue. However, the ILO has adopted a Resolution establishing that "collective bargaining remains at the heart of social dialogue. Consultations, exchanges of information and other forms of dialogue between social partners and with governments are also important."

Social dialogue, based on respect for freedom of association and the effective recognition of the right to collective bargaining, has a crucial role to play in designing policies to promote social justice. It is a means to achieve social and economic progress and is essential for democracy and good governance. Social dialogue comes in various forms and at different levels. The ILO has published a wide range of documents, manuals and guidance on social dialogue practices, including two with a sectoral focus applicable to the transport and maritime sectors:

Social dialogue in the railways sector (2015)

Social dialogue in the process of structural adjustment and private sector participation in ports: A practical guidance manual (2006).

Source: ILO, Resolution concerning the second recurrent discussion on social dialogue and tripartism (2018). Online: www.ilo.org/sites/default/files/wcmsp5/groups/public/@ed_norm/@relconf/documents/meetingdocument/wcms_633143.pdf.

a. Impact on pay structure

Workers should share in the benefit which technical progress brings to the undertaking; and measures should be taken to minimize the adverse effects which technical changes might have on their job roles and compensation. Governments should encourage companies to keep their workers informed of the changes brought about by the technological advancement. They should also encourage an open dialogue between management and workers concerning technical changes planned as soon as possible. Where necessary, negotiations should be required between the representatives of intermodal transport and logistics employers, their associations, and those of the workers concerning the repercussions of those changes on pay structure.

b. Opportunities and challenges

Workers who are at risk of job displacement resulting from automation will face a number of opportunities and challenges in transitioning into the jobs that are expected to be created by the structural changes brought about by automation. Some possible impacts of digitalization and automation on working conditions and labour protection may include earnings, working time, job security, skills development and career progression, safety and health at work, social environment, freedom of association and collective bargaining and equality of opportunity and treatment. It is also important to acknowledge that affected workers may not necessarily be directly shifted into these newly created roles; instead, they might need to seek employment in entirely different industries, requiring additional support for retraining and skills development.

3. IMPACT ON WORKFORCE: TRAINING, RETRAINING, UPSKILLING

If technical progress results in higher job requirements or changes in job nature, for instance, increased responsibilities, physical or mental effort, or in the technical skills required of workers holding certain positions, it is important that these roles are appropriately upgraded, taking these new factors into account.

A well-trained workforce is essential for efficient freight intermodal transport and logistics operations. The objectives of training should be to provide workers with skills necessary for the safe and efficient performance of their work. Training needs at all levels, particularly in times of change, should be addressed on a consultative basis. Consideration should be given to providing vocational training at no cost to the employees; it should be carried out at ports, railway facilities or other training centres. Governments, in consultation with intermodal transport and logistics employers, their associations and workers' representatives, should facilitate the development and introduction of appropriate training standards and certification of trainers and trainees. Compliance with such standards should be monitored and enforced. Where appropriate, joint training boards responsible for establishing training standards and curricula and for supervising the quality of training should be set up and facilities for worker training should be provided. Workers should be given every opportunity to undertake necessary training.

a. Redundancy and redeployment

Technological and organizational changes may lead to a reduction in employment requirements. In such cases it is necessary to give priority to the use of available resources in the enterprise to retrain and redeploy existing employees. The roles of the social partners in minimizing job losses should conform with established agreements, conventions or recommendations, as appropriate.

In coping with the problem of redundant employees, governments should encourage intermodal transport and logistics employers implementing automation to – as a first step – make special efforts to redeploy them in consultation with workers and their organizations, and in accordance with applicable international labour standards and national laws or collective agreements, as appropriate. Depending on the circumstances and possibilities, they should endeavour to:

- Transfer workers to other suitable jobs within the same undertaking; or
- Secure, with the collaboration of other undertakings, the governments and, where appropriate, the trade unions concerned, alternative employment outside the undertaking for redundant workers, with a minimum of financial hardship to the workers concerned.

b. Training and retraining programmes

Special retraining schemes should be designed to meet the specific needs of redeployment, which may not necessarily be in the same industry. To the extent possible, the retraining should be based on the profile of each worker affected and the new job requirements; it should also include assistance to the worker in adapting to the new job. Intermodal transport and logistics employers, their associations, and workers' organizations should promote policy and legislation that facilitate retraining for redeployment.

Governments, as well as intermodal transport and logistics employers, their associations, and workers' organizations, have special roles to play in determining and meeting the training needs arising from the restructuring and automation programmes:

- Governments should provide the basic education and technical foundation.
- Intermodal transport and logistics employers and their associations should provide the necessary, job-specific training based on assessments of skills required for new technologies and work methods.
- Workers' organizations should inform intermodal transport and logistics employers or their associations about workers' needs, and possibly participate in the planning, implementation, evaluation and improvement of training programmes.

Tripartite training programmes should, to the extent possible and depending on national circumstances, be related to competency standards and the awarding of broad-based qualifications, as these can improve the workers' job prospects, facilitate their redeployment and prevent redundancy in their current jobs.

While training programmes need to be adapted to specific cases, there is a general need to promote technical skills and qualifications that can enhance efficiency and quality of service. Skills in the area of new technologies, digitalization and automation are becoming increasingly important. Furthermore, depending on the redeployment and redundancy measures adopted – such as attrition, hiring freeze and/or early retirement – additional needs for retraining should be made available. At the same time, however, training and retraining programmes should, to some extent, shift their emphasis from the acquisition of traditional management and craft-specific skills, which have become less important, to broader skills. In the context of increasingly digitally based and automated world of work, greater autonomy at work, as well as a growth in virtual communication, requires workers to develop and strengthen certain core skills. These comprise digital skills, critical thinking, self-reflection,

problem-solving, advanced interpersonal skills (negotiation, conflict resolution, communication and collaboration), emotional intelligence, creativity and innovative thinking, planning and organizing, career management, and learning to learn. This should also include training on how to implement the UN standards in digitalization projects.

c. Labour adjustments: redundancy and separation

The implementation of automation will lead in most cases to restructuring. If redundancy results from restructuring plans and cannot be fully coped with through redeployment efforts, then the intermodal transport and logistics employers, their associations, and workers' organizations, within national law and practice, should work out with governments suitable redundancy schemes that can effectively prevent, or at least minimize, negative effects on workers. Since workers are not necessarily at the root of redundancy, the social cost of the necessary labour adjustments should be shared by society equitably. Government should encourage intermodal transport and logistics employers and their associations to prioritize measures that are least intrusive to the workers and impose minimal strains on the entity's human resource capacity, such as attrition, hiring freeze and early retirement. Separation should be a measure of last resort. If it cannot be avoided, it should involve financial compensation and other suitable forms of assistance that can ease the reintegration of workers in the labour market.

Redundancy and separation should be assessed, negotiated, and mitigated in the context of its causes. It should not be a result of unfair labour practices, nor of hasty restructuring programmes that can result from deficiencies in legislation or collective bargaining machinery, or from inadequate planning. To ensure fairness, Government should ensure, through legislation or otherwise, that workers have the right to have their redundancy payments negotiated through clear procedures established, ideally with compensation calculated through mutually agreed formulas.

d. Loss of jobs and budgeting for retraining schemes

Loss of jobs will pose major challenges for automation and restructuring, even when acceptable severance payments are negotiated with workers. To cope with these problems, retraining programmes should be organized to help affected workers who lose their jobs to find alternative employment. Particularly for workers who are older, have low and/or non-transferable skills and/or live in remote areas with few employment opportunities, governments should provide special assistance measures to smoothen their adjustment. Small business loans and retraining loans at subsidized rates, as well as job-creation funds should be considered; if feasible, they should be supplemented with technical assistance.

In addition to training programmes to assist redeployment efforts and to enhance skills and work-related attitudes, government training programmes should be designed in consultation with intermodal transport and logistics employers, their associations and workers' organizations for workers who lose their jobs. In situations where lay-offs cannot be avoided, the governments should, where necessary, establish labour-market adjustment schemes whereby affected workers are provided an agreed amount of time off for participation in training courses.

C. FINANCING, INCLUSIVENESS AND SMALL AND MEDIUM SIZED ENTERPRISE FRIENDLINESS

Automation and digitalization may require significant infrastructure investment, which may become prohibitive for small and medium enterprises. This comes in addition to a transport and logistics infrastructure deficit in place in many countries and a need to increase public sector expenditure or promote private sector involvement.

Governments play a key role in regulating and financing freight intermodal transport and logistics infrastructure and services. These can be delivered either through debt financing to leverage limited capital for larger projects or under public and private operations, with various degrees of outsourcing and other forms of contracting and subcontracting. Policy responses, including the design of financially balanced and comprehensive contracts to regulate the terms of operations, are needed to promote a level playing field in order to respond to diversity in context and fluctuating demand. Decent work is a central element relevant to these policy responses.

Governments can also support intermodal and logistics enterprises and their associations in gaining access to suitable sources of debt or equity finance, by facilitating business plans and financing applications, identifying potential lenders or investors, and making necessary introductions. This support can also include working closely with a range of financial institutions, including foreign and local banks, international investment institutions, leasing companies and venture capital funds. It also collaborates with various donor-provided credit lines, e.g., from the World Bank, European Union, etc.

Governments play a pivotal role in facilitating this transition into digitalization and automation also through investment in software-based technological solutions. These may include providing open data and assistance in using interoperable standards. By allocating resources in these software solutions, the government could reduce the barriers to entry into automation and digitalization, and thereby improve competitiveness in the freight transport and logistics sector.

It is also important for governments to ensure automation and digitalization do not lead to unfair advantages for certain companies or hinder competition. Appropriate policies should be put in place to encourage interoperability and data sharing, enabling different stakeholders to collaborate and compete on a level playing field. Examples of which may include:

- **Regulatory and policy frameworks** – Ensure comprehensive and fair regulations. Developing and enforcing regulations that ensure fair competition and prevent monopolistic practices will provide small and medium-sized enterprises (SMEs) with equal opportunities to participate. Contracts for public projects may include provisions that facilitate SME participation, such as simplified bidding processes and appropriately sized project splitting.
- **Infrastructure and technology access** – Support digital infrastructure. Development and maintaining government-operated digital platforms that provide essential services and tools for automation and digitalization may be beneficial. Making these platforms accessible to SMEs at no or minimal cost may reduce entry barriers. Investment in public digital infrastructure, such as high-speed internet and cloud services, especially in underserved areas, could ensure that SMEs can leverage these technologies. Facilitating development of shared digital resources that SMEs can utilize, such as cybersecurity tools and data analytics platforms, may also be advantageous.

- **Capacity building and technical assistance** – Provide training and advisory services. Government-sponsored training programmes could help upskill the SME workforce in digital literacy, automation and advanced logistics management. Collaboration with educational institutions to integrate relevant skills into curricula and provide continuous professional development opportunities might be useful. Establishing technical support centres that offer advisory services to SMEs on best practices in automation and digitalization could be helpful. Providing consultancy services to assist SMEs in identifying suitable technologies, implementing digital solutions, and optimizing their operations may be beneficial.
- **Innovation and collaboration** – Facilitate knowledge sharing. Creating innovation hubs and clusters where SMEs can collaborate with larger companies, research institutions, and government agencies might be valuable. Public-private partnerships focused on research and development in automation and digital technologies could provide opportunities for SME participation. Organizing conferences, workshops, and networking events that bring together stakeholders from across the sector to share knowledge and best practices may foster innovation. Developing online platforms for continuous information exchange, including case studies, success stories, and technical guidelines, could be beneficial.
- **Inclusiveness and decent work environment** – Support SME associations. Strengthening and supporting SME associations could ensure they are represented in policy dialogue and negotiations. Facilitating the creation of consortiums and networks where SMEs can collaborate, share resources, and advocate for their interests collectively might be useful.

There are already various projects in place in the pan-European region to help SMEs transition towards digitalization and automation in freight transport and logistics. For example, the European Funds for Infrastructure, Climate, Environment 2021-2027 allocated €230 million in total (€160 million for the TEN-T network and €70 million for other networks) for constructing and reconstructing intermodal terminal infrastructure, purchasing or modernising rolling stock and equipment for intermodal terminals, and investing in telematics and satellite systems. This strategic investment ensures the necessary infrastructure for SMEs to participate in the transition to automated and digitalized freight operations. The National Recovery and Resilience Plan in Poland is another initiative supporting the digitalization and automation of freight transport. The Plan allocates €175 million for the construction or reconstruction of intermodal terminals and associated infrastructure, including road connections, railway sidings, and lines linking terminals with broader transport networks. This investment also extends to the purchase or modernisation of zero-emission rolling stock and equipment for intermodal terminals, supporting the shift towards more sustainable transport solutions. Additionally, funds are directed towards the implementation of advanced IT systems and telematics, as well as satellite systems, to optimise terminal operations and enhance the efficiency of intermodal transport. These investments foster SME participation by providing the modernised infrastructure and digital tools needed to engage in a more sustainable and technologically advanced freight ecosystem.

Box III
Navigating Fiscal Responsibility and Debt Sustainability in Developing Economies

In some countries, governments grapple with structural conditionalities that seek to reduce fiscal exposure to fluctuations in revenues, and, in some cases, they further have been compelled to introduce certain fiscal responsibility measures, which include ceilings on expenditure growth, debt ceilings and a ceiling on the structural deficit. For example, debt sustainability has deteriorated in a number of countries. In the past ten years, external debt has risen at an average annual rate of 8.5 per cent for developing countries, and in 2018 totalled US$7.6 trillion. The United Nations Conference on Trade and Development (UNCTAD) has warned of the fragility of developing economies and provided guidance on how they can mitigate growing debt vulnerabilities. Countries with a higher risk of debt distress may face challenges in finding investments for transport projects, including for its digitalization and automation. Yet, high investments in technology, digitalization and automation may push governments to seek increasing levels of private sector participation to bridge these gaps.

IV. EXAMPLE OF DIGITALIZATION AND AUTOMATION

The various enabling technologies for digitalization and automation of intermodal freight transport, and how they could improve efficiency or create positive impacts on the reduction of energy consumption, greenhouse gas emissions, etc will be discussed in this section. The following are some of the enablers that are fundamental in realizing the various solutions in digitalizing and automating the freight transport sector:

- Internet-of-Things (IoT) – it refers to the network of physical devices, vehicles, and other items embedded with electronics, software, sensors, actuators, and connectivity which enables them to connect, collect, and exchange data (e.g. data on location, temperature, humidity, and other relevant parameters). IoT technology enables large volume of data to be collected from a wider range of objects that were otherwise costly to collect before, enabling more parameters to be considered during forecasting and monitoring.
- Reliable communication network – such as 5G or LoRaWAN, is essential for transmitting data from IoT sensors to various management solution platform(s). 5G is the latest generation of cellular network technology that is designed to support high-speed, low latency connectivity. LoRaWAN on the other hand, is a low-power, wide-area networking protocol designed for long-range communication with low data usage. It is optimized for battery-operated devices and sensors that need to transmit small amounts of data over long distances, making it ideal for monitoring sensors that require deployment over a wide area and need to communicate wirelessly with a centralised network.
- API and open standards – closed, proprietary-by-design simulation tools are progressively being phased out in favour the availability of open standards and public application programming interfaces (APIs). APIs essentially set out a set of rules, protocols, and tools that allow different software applications to communicate with each other. APIs define the methods and data formats that developers can use to interact with a service, library, or operating system. APIs have dramatically streamlined sharing and data exchanges, making it possible for users to combine data from different sources quickly and reliably for their own analysis and modelling.
- Artificial intelligence and machine learning: they make more complex and sophisticated modelling feasible thanks to continuously improving computing power and availability of big data. Machine learning frameworks are enabling the development of systems that allow autonomous decisions to be made, taking into account predictions on future operating conditions based on historical and real-time data.

These enablers lay the foundation for the various applications of digitalization and automation in intermodal freight transport. In the next section, the discussion will be organized into solutions designed for various stages in the intermodal transport chain. These include business analytics solutions for operators, solutions to enhance safety and efficiency in terminal operations, and solutions tailored for railway carriers. Each subsection will provide an overview of these solutions, complemented by case studies in the annex from member States illustrating their applications where applicable.

A. SOLUTIONS FOR BUSINESS ANALYTICS

1. DATA AND INFORMATION EXCHANGE AND MANAGEMENT PLATFORM

An effective data and information exchange and management platform should facilitate information and data to flow seamlessly and efficiently amongst all stakeholders involved in the intermodal transport journey. In particular, it should be able to reflect timely the status of the consignment through IoT-enabled devices and sensors. These data would not only allow more efficient tracking but enable more precise route management that minimizes idle time, as well as predictive analysis with the availability of big data for better resource allocation and management.

While various systems already exist to facilitate such data and information exchanges, they often lack interoperability, restricting their functionality to local or regional contexts. Despite advancements, the integration of diverse systems across different modes of transport remains a significant hurdle. This lack of interoperability inhibits seamless communication and coordination among stakeholders involved in intermodal transport, impeding efficiency and hindering the realization of a truly interconnected global transport network. As the demand for efficient and sustainable transport solutions continues to rise, addressing the issue of interoperability is paramount for unlocking the full potential of data and information exchange in intermodal transport.

2. DIGITAL TWINS

This digital twin serves as an innovative information and analytical platform aimed at facilitating decision-making regarding infrastructure maintenance. It is a virtual representation of an object or system designed to reflect its physical counterpart accurately. It enables the simulation of operational tasks, predictive analytics, and forecasting of infrastructure facility conditions and planned repairs using both real-time and historical data.

Below are some examples of the applications of digital twin in optimising intermodal freight transport:

- Maintenance Planning: The digital twin enables a shift towards flexible and targeted planning for infrastructure asset maintenance and repair activities.
- Asset Renewal (Modernization): Utilizing data on the remaining resource, the digital twin facilitates the implementation of infrastructure technical asset renewal and modernization efforts.
- Route planning: Digital twins enable real-time monitoring of factors such as cargo load, train performance, and track conditions, allowing operators to optimize routes based on factors like optimal speed, cargo distribution, and scheduling to maximize efficiency and reduce operational costs. Additionally, by simulating various scenarios, digital twins help anticipate and mitigate potential disruptions, enabling proactive decision-making and enhancing overall supply chain resilience in freight railway transport.
- Training Organization with VR Technologies: Virtual Reality (VR) technologies are leveraged to provide immersive training experiences, allowing operating personnel to engage in virtual environments without the risk of physical injury.

- Technical Documentation Maintenance: Automation and data-driven processes are employed for the maintenance, generation, and editing of technical documentation. This is achieved by accumulating data from various systems to inform documentation management.

B. SOLUTIONS AT TERMINALS

1. AUTOMATED SYSTEM FOR ENTRY AND EXIT TO/FROM TERMINALS

Automated system for entry and exit to/from terminals leverage on various enablers to automate the process of checking in and out of terminals for freight vehicles. Key components and infrastructure required for such systems include:

- Vehicle Identification and Authentication: Automated systems utilize technologies such as RFID (Radio Frequency Identification), license plate recognition, or biometric authentication to identify and authenticate vehicles entering and exiting terminals. This infrastructure includes RFID readers, cameras, and sensors installed at entry and exit points.
- Automated Gate Systems: Automated gate systems replace manual processes with self-service kiosks or electronic gates equipped with scanners and sensors. This could be integrated with weighing stations equipped with weighbridges or scales. As vehicles pass through the weighing station, sensors detect the vehicle's weight automatically, obliviating the need for manual checking and weighing.
- Integration with Backend Systems: Automated entry and exit systems should also be integrated with backend systems, such as terminal management software or freight management platforms, to streamline data exchange and processing. Data and information captured at check-in should be forwarded to the backend management systems without manual interventions. These include updating inventory records, generating billing invoices, and recording transaction logs etc. This integration ensures real-time visibility of vehicle movements, cargo status, and terminal capacity, enabling proactive decision-making and resource allocation.
- Security and Surveillance Infrastructure: To ensure security and compliance with regulations, automated systems may include surveillance cameras, access control mechanisms, and biometric authentication devices. These measures help prevent unauthorized access, detect security threats, and maintain the integrity of the terminal operations.

2. AUTOMATED CRANES AND VEHICLES WITHIN TERMINALS

Automated cranes and vehicles in terminals can significantly reduce reliance on manual labour and mitigate the need for workers to perform unappealing tasks in challenging environments. This automated infrastructure could replace tasks such as container stacking, transport, and truck handling, thus minimising the risk of injuries and occupational hazards associated with manual labour.

3. AUTOMATED SLOT MANAGEMENT FOR TRUCKS AND TRAINS

Automated slot management systems utilize advanced algorithms and real-time data to allocate time slots for any modes entering and exiting the terminal, ensuring smooth operations and minimizing delays. With AI-enabled algorithms, the systems could potentially optimize the allocation of terminal resources, including loading docks, berths, and rail tracks, based on demand forecasts, vessel schedules, operational constraints, and enable dynamic adjustment based on real-time information brought about by digitalization of information and data exchange.

It is important to recognize that AI-enabled algorithms are relatively novel in the context of intermodal transport, and they rely heavily on extensive data, both historical records and real-time, to effectively drive the processes of machine learning and decision-making. They should not be perceived as a panacea that will instantaneously enhance efficiency and productivity. Instead, the possibility of errors and miscalculation in scheduling should be acknowledged, and contingency plans should be formulated to mitigate such risks. Automated slot management systems for trucks and trains are not intended to completely replace human labour, but rather to complement the existing efforts of scheduling personnel. Schedule makers should be upskilled, making them capable of refining and optimizing the algorithms in slot management. Moreover, they should be prepared to intervene and resolve any issues should the systems fail to respond effectively to address real-world challenges.

C. SOLUTIONS FOR RAILWAY CARRIERS

1. AUTOMATED INSPECTIONS, MAINTENANCE OF RAIL INFRASTRUCTURE AND RISK ASSESSMENT SYSTEMS

These systems aim to improve the reliability of rail services through more efficient monitoring and maintenance of its infrastructure using sophisticated IoT-enabled sensors.

A number of the applications of these solutions are provided below:

- Digital Model and Predictive Analytics for Tracks: Implementing a digital model and predictive analytics system to forecast the technical condition of tracks. This will automate the planning of repairs and maintenance based on forecasted data.
- Predictive Analytics for Signalling Devices: Utilizing predictive analytics to forecast the technical condition of signalling devices based on diagnostic data.
- Maintenance and Repair Programs: Formulating maintenance and repair programs based on the forecasted technical condition of railway equipment. This includes automation and telemechanic systems.
- Life Cycle Management System: Introducing an information system for the life cycle management of track machines and mechanisms.
- Automated Documentation Maintenance: Implementing a system for automated maintenance and updating of technical documentation.

- Predictive Analysis for Freight Cars: Introducing tools for diagnosing rolling stock while trains are in operation to conduct predictive analysis of freight car technical condition.
- "Virtual coupling": Enabling the synchronized movement of two freight trains with minimal distance between them, facilitated by coordination of locomotive driving modes through a secure digital radio channel. An intelligent system monitors location, speed, speed changes, and distance to the leading train. It can increase capacity of railway sections without compromising on safety, simplify work for locomotive crews and increased their operational speed.

2. DIGITAL AUTOMATIC COUPLING AND DECOUPLING

Digital Automatic Coupling (DAC) connects wagons to form a train. DAC has different levels according to their stage of development. What makes DAC special is that this connection, or coupling procedure, is automated. From DAC Level 4, wagons could be automatically coupled with a continuous electricity supply and a consistent data connection.[6] This will enable wagons in the future to communicate with each other and with the locomotive. Uncoupling at DAC Level 4 is partially automated and is expected to be in use by 2030. This technology will be an important enabler and prerequisite for automated and autonomous locomotives.

DAC could also reduce risk of human error and minimize the potential for accidents or injuries during coupling and decoupling operations.

3. AUTOMATED LOCOMOTIVES

Automated locomotives are trains that operate without direct human intervention for controlling their movement. Instead, they rely on a combination of advanced technologies such as AI, sensors, cameras, GNSS, and communication systems to navigate, monitor their surroundings, and make decisions.

Automated locomotives could have the potential to optimize train movements for improved efficiency, reducing energy consumption and minimizing delays. However, safety continues to be of paramount concern in automated train systems. Many of the automated locomotives at present are operated in local, isolated networks, given the challenges in ensuring interoperability with existing infrastructure, addressing cybersecurity concerns, and navigating regulatory frameworks governing autonomous transport in the railway sector.

[6] There are currently five different levels for automatic coupling. The higher the level, the more features there are. Automated coupling from Level 3 upwards is considered DAC, because a power cable could also be automatically coupled. Several Level 4 prototypes exist right now and are undergoing extensive tests. The goal for the future is to have a Level 5 DAC system where uncoupling is also automated.

ANNEX – *CASE STUDIES*

I. SOLUTIONS FOR BUSINESS ANALYTICS

A. ELECTRONIC FREIGHT TRADING PLATFORM (ETP GP) – SUBMITTED BY RUSSIAN FEDERATION

KEYWORDS: BUSINESS ANALYTICS, CUSTOMER RELATIONS, ONLINE SALES, DATA AND INFORMATION EXCHANGE AND MANAGEMENT PLATFORM

1. Objective

Online sales of the Russian Railways Group's services in the field of freight transportation and integrated transport and logistics products, a single digital space for freight transportation and logistics (interaction between customers and service providers when organising transport and logistics services using modern digital technologies).

In March 2017, as part of the digitalization of railways, Russian Railways put into commercial operation the Freight Transportation Electronic Trading Platform (ETP GP).

The main function of the ETP GP is to provide any client in electronic form with an optimal offer for the provision of basic transportation services with the provision of rolling stock for this transportation.

Its operational mobility and available algorithms have created a steady trend to expand the audience of users due to effective parity in the processing of applications, their on-line approval, transparency of payments for services, timely execution and issuance of accompanying documentation, including the railway consignment note in an electronic legally significant form. And the technological level of ordering transportation has acquired all the necessary features of modern electronic services.

Thus, for the first time, the Russian transport market was offered an end-to-end electronic service: from the moment the customer contacted Russian Railways to the completion of transportation.

2. Application, benefits and costs

The ETP GP enables digital interaction with freight forwarders, allowing the formation of transport contracts for shipments to CIS countries and the exchange of data throughout the order execution process. Russian clients and exporters can carry out international rail transportation through border crossings involving railways that have joined the ETP GP terms, without the need to establish contractual agreements between the client and the railway administration of the neighbouring country.

The electronic trading platform offers a wide range of services:

- Station-to-station transportation service in both universal and specialized rolling stock;
- Terminal services. It is part of the logistics chain of transportation at the final or intermediate delivery point. This service may include loading, unloading, transshipment and storage of cargo;
- Auctions in lots of rolling stock. Substation lots are a system of bidding for rolling stock within the site, bidding takes place on an increase for the possibility of providing wagons for individual transportation. Any confirmed user of the ETP GP has the opportunity to take part in the auction;
- Payment for transit, import. Import, export, transit freight forwarding services;
- Search for schemes and drawings. A database of schemes and drawings of cargo placement and securing on/in rolling stock.

The algorithm of the site is arranged in such a way that after the client-shipper fills in the single application template, the ETP GP automatically sends its parameters to all service providers connected to it. Suppliers, in turn, send their proposals to the organization of transportation and the provision of rolling stock.

If the operator has previously formed an offer for a wagon and the client has accepted it, an application for transportation is automatically generated and the wagon is "sent" for the declared transportation. Upon arrival of the wagon and completion of loading, the consignor draws up a transportation document. Moreover, he can independently track all transactions with the car and its current location in his personal account.

Registration on the ETP GP is carried out remotely, without a visit to the office. Payment for services for customers is made on the basis of an automatically generated invoice and an act of services rendered after the completion of transportation. The consignor chooses the forms of payment available to him: according to the presented invoice or by forming advance payments on a single personal account opened with the operator of the ETP GP.

3. Lessons learned

The relevance of the ETP GP is confirmed by the positive dynamics of its performance indicators. Since the platform's inception, the number of active users has been steadily increasing. Currently, more than 9,800 clients are registered on the platform. The highest level of activity outside Russia is shown by shippers from Belarus, China, and Kazakhstan. The platform has 147 registered service providers, of which 134 are rolling stock operators.

B. TARO – TOWARDS AUTOMATED RAILWAY OPERATION – SUBMITTED BY AUSTRIA

KEYWORDS: DIGITAL TWIN, AUTOMATED COUPLING, BUSINESS ANALYTICS, TERMINALS

1. Objective

Rail is now widely regarded as the most-environmentally-friendly form of surface transport, and yet there is an urgent need to increase capacity, productivity as well as quality of the railway. These key challenges will be tackled by the project TARO ("Towards Automated Railway Operation").

Not only in terms of railway usage, Austria is a leading railway country in the European Union (no. 1 passenger-kilometres per capita, no. 2 freight transport, no. 1 night trains) but also regarding its railway industry (no. 5 global export, no. 1 in railway patents per capita). Given such an excellent starting position, taking railway to the next level with the help of automation and digitalization technology should be self-evident. Hence, the submitted project proposal "TARO" focuses on 3 different areas:

- Digital Twin development of digital twin vehicle with special regard to condition-based maintenance and predictive maintenance; development and simulation of digital twin infrastructure, as it is one of the fundamentals of automated train operation;
- Process automation in freight transport, in particular in terms of automated coupling, as well as shunting and planning;
- Automated railway solutions such as low-cost autonomous on-track side elements, low-cost train control systems for regional lines, as well as location of vehicles.

2. Application, benefits and costs

The estimated project results are expected to contribute to an increase in capacity, productivity and quality of the entire railway system. To guarantee that these results are achieved, a steering board consisting of national and international railway experts will be established.

The results could either be successively transferred to real operation or further processed in subsequent R&D projects. It was for example possible to create the basis for a digital twin vehicle. The results are now to be further developed. Furthermore, a mathematical model for the optimized scheduling of freight wagons was designed. This is now to be successively incorporated into regular operations, make the work of dispatchers easier and make rail freight transport more attractive overall. In addition, tests of the digital automatic coupling in Austria were accompanied and evaluated and migration strategies were developed.

3. Lessons learned

Ongoing project – no applicable.

II. SOLUTIONS FOR TERMINALS AND RAILWAYS OPERATIONS

A. DACIO – DIGITAL AUTOMATED COUPLING IN INFRASTRUCTURE OPERATIONS – SUBMITTED BY AUSTRIA

KEYWORDS: AUTOMATIC COUPLING, TERMINAL OPERATIONS, RAILWAY OPERATIONS, DAC4EU

1. Objective

Today's rail freight services suffer from out-dated coupling and shunting processes, mainly due to screw couplings, which prohibit state-of-the-art automation. Due to this situation, especially wagon load traffic is very often no longer competitive. Current research within the project DAC4EU and the subsequent project "European DAC Delivery Program" (EDDP) are paving the way for the introduction of a Digital Automatic Coupling (DAC) system for use within Europe. The new technology of DAC shall lead to an increase in productivity and will enable the rail freight system to connect to state-of-the-art technologies analogous to developments in industry 4.0.

For the successful implementation of the DAC, additional research into automatic coupling and decoupling, as well as all related processes is the main focus of the DACIO project (DACIO – Digital Automatic Coupling in Infrastructure Operations). Examples of these are the bleeding of the brakes and the brake test itself. This research project is based on the planned introduction of the DAC type 4. Type 4 will enable all steps to be performed automatically, with the exception of the decoupling.

The DACIO project has the following goals:

- Investigation of the impact of the DAC on the of the area-wide coverage processes;
- Scientific support of the test program, which is planned within the EDDP. This support is focused on the shunting processes in the marshalling yard and in the wide-area;
- Research into additional processes in the marshalling yard which could be automated. Appropriate functional models and lab prototypes will be delivered. Of keen interest are the decoupling and the handling of the brakes before and after the gravity hump. Additionally the question of a safe roll-away protection of the trains will also be taken into consideration;
- Research into additional automation steps on the wagon, with a focus on developing novel brake systems and a possible array of sensors used to detect the approach to other wagons;
- Research into the impact of the DAC on the structure and scope of the shunting infrastructure. The main goal is to increase the efficiency of the rail freight system.

The DACIO project should help to further the goals of EDDP, in addition to providing initial findings, which could lead to future pilot projects within the new program Shift2Rail2.

2. Application, benefits and costs

Ongoing project – not applicable.

3. Lessons learned

Ongoing project – not applicable.

B. RAIL CONNECTED PORT OF ROTTERDAM – SUBMITTED BY THE NETHERLANDS

KEYWORDS: RAILWAY OPERATIONS, DIGITIZATION OF RAIL PROCESSES, ROTTERDAM

1. Objective

The "Rail Connected" growth programme arose from the Rail-freight Transport Package of Measures drawn up by the Dutch Ministry of Infrastructure and Water Management to promote freight transport by rail. The 'Rail Connected' programme is funded by the Ministry of Infrastructure and Water Management of the Netherlands and the Port of Rotterdam Authority. The Port of Rotterdam Authority coordinates the programme, which is developed together with market parties. The programme started in 2022 and is intended to finish at the end of 2025. The Ministry provided €1 million for the period from 2022-2024 and intends to provide in addition €200,000 in 2025.

The aim is to use digitalization to streamline information-sharing between carriers, rail operators and terminals, thus reducing manual operations. The first step has been taken: pre-reporting of trains. Once a week, everyone submits a digital report stating which trains are planned for the coming week. Step 2 – "train composition" – enters final testing in January 2025. That means greater clarity in a digital environment on the composition of freight trains arriving and departing Rotterdam in terms of locomotive, wagons and containers.

Recently the twenty-fifth market party joined Rail Connected, this means that the Rotterdam rail-freight sector is almost completely covered.

2. Application, benefits and costs

Key to every digitalization process is to use existing interface standards. The European Union Association for Railways (ERA) already has standards for consignment note and train data, yet there are still differences in between, for instance, how terminals and carriers code locations in their systems. In "Rail Connected" these disparities are being solved. The perspective of greater efficiency, transparency and reliability beckons.

Pre-reporting of the train arrival is up and running. Train composition message is almost ready for launch. In 2024, the estimated time of arrival (ETA) function will go live. Traction suppliers need to add the train number in MCA (Notification Container Hinterland) Rail application of Portbase, so that it can be linked to the "path" via the RailNetEurope Train Information System. Sensors in the track enable ProRail, the Dutch rail infrastructure manager, to monitor and update the ETA along these paths and to optimize the use of railway capacity by a more efficient capacity allocation process. ProRail is currently working on additional use of cameras and sensors, so that all applicable routes provide information.

The next step is to draw up an integrated plan of how we could use the digitized processes, and the data derived as a result, to optimize loading, train paths and terminal utilization.

3. Lessons learned

The main lesson learned is to involve market parties from the start. Without their commitment from the very first moment these processes are doomed to fail. Taking the digitization process step by step further in the pace that fits with the market party that leads to successful implementation of projects.

III. SOLUTIONS FOR INTEROPERABILITY

A. DEVELOPMENT OF ELECTRONIC E-CIM/SMGS RAILWAY CONSIGNMENT NOTE TO ENHANCE INTEROPERABILITY ACROSS THE TRANS-CASPIAN AND TRACECA ROUTES, USING THE UN/CEFACT SEMANTIC STANDARDS AND MULTIMODAL TRANSPORT REFERENCE DATA MODEL – SUBMITTED BY TRACECA AND UNECE

KEYWORDS: INTEROPERABILITY, DIGITALIZED DATA EXCHANGE, UN/CEFACT STANDARDS

1. Objective

Adopting a single, standardized electronic format for a document accompanying goods transported by rail along the Trans-Caspian/TRACECA corridors (CIM/SMGS consignment note) using the UN/CEFACT semantic standards and Multimodal Transport Reference Data Model (MMT RDM) to streamline processes, enhance efficiency of movements of cargo across borders, and pave the way for multimodal data and document exchange along corridors by using the UN/CEFACT standards.

As with other pilot projects for the implementation of the UN/CEFACT package of standards, this project builds on the understanding that fragmented digitalization efforts in increasingly multimodal trade and transport corridors and cross-border supply chains are suboptimal. The project focused on the use of UN/CEFACT semantic standards and MMT RDM as a link between different solutions for data exchange in the railway industry, the different modes of transport and segments in the supply chain.

The project was elaborated and is implemented in cooperation between ECE, its subsidiary body UN/CEFACT, the Permanent Secretariat of the Intergovernmental Commission of TRACECA, the International Rail Transport Committee (CIT), the International Union of Railways (UIC), and the Organization for Co-operation between Railways (OSJD).

Countries along the Trans-Caspian route currently exchange railway consignment note data in various formats: SMGS (Azerbaijan, Georgia, and Kazakhstan) and some use the UN/EDIFACT IFTMIN message for electronic data interchange of the SMGS consignment note data; CIM (Türkiye), or the combined CIM/SMGS (Ukraine). The objective of this pilot implementation was to test the feasibility of digitalizing a common consignment note (CIM/SMGS). The objective included:

- Adoption of UN/CEFACT standards: by implementing UN/CEFACT standards ensure universal compatibility of the digitalized railway consignment note with other railway exchanges and easy integration in seamless data sharing in multimodal data and document exchange and the whole supply chain.

- Development of a prototype of an electronic CIM/SMGS consignment note that is testable and scalable, serving as a practical model for future system-wide adoption.
- Facilitate multimodal transport and simplify data exchange by promoting easier exchange of data in a standardized format across countries to support multimodal transport.

2. Application, benefits and costs

Five railway agencies along the Trans-Caspian trade and transport corridor signed a memorandum of understanding to carry out a pilot implementation project for the digitalization of the CIM/SMGS railway consignment note using the UN/CEFACT multimodal interoperability standards and reference data model. This implied creating a working group and several ad hoc task forces, developing a prototype based on the standards and testing it.

The core consultant under the project, who had to develop and guide the test of the eCIM/SMGS consignment note, started with engagement with the UN/CEFACT standard-setting experts for deep insights in the development and use of the international standards. The project then moved from theory to practice in applying the UN/CEFACT standards.

Through strong support from the Permanent Secretariat of the Intergovernmental Commission of TRACECA and UNECE, the next stage covered collaboration and information exchange with the practical users of the digitalization of the CIM/SMGS consignment note. Azerbaijan and Türkiye provided PDF files with the core SMGS and CIM/SMGS data. Kazakhstan shared IFTMIN examples for mapping to the UN/CEFACT MMT RDM and the CIM/SMGS. Georgia contributed with SMGS PDFs for integration. The PDF versions of consignment notes were converted into electronic CIM/SMGS for data mapping, and the results of the data mapping were shared with the working group on the project. The outcome was a unified, standard-focused electronic document equivalent developed from the diverse data formats. The lessons learned, including challenges for railways to change the course from divergent digitalization formats and projects, were very useful. The international cooperation and data sharing enhanced the project.

The Prototype Testing included the following stages:

- The tests started with XML file exchange by e-mail for the test in April 2024.
- The XML file exchanges tested global compatibility and adherence to best practices in data exchange and the use of the global (UN) standards.
- The initial testing among partners produced feedback and lessons, which should lead to further improvements, testing and refinement.
- In their information technology systems, country railways tested and adopted the possibility to export and import e-CIM/SMGS XML files.
- By June 2024, Azerbaijan, Türkiye, and Kazakhstan finalized the tests, while Georgia and Ukraine continued their tests.

Figure II
Snapshot example of an XML message for the CIM/XML consignment note

```
(663404) - Almaty 1, KZH (70007)
    </ram:PackageType>
    <ram:ContractTermsInformation languageID="XXXXXXXXXX" languageLocaleID="XXXXXXXXXX">XXXXXXXXXX</ram:ContractTermsInformation>
    <ram:TotalTareWeightMeasure unitCode="KGM">23</ram:TotalTareWeightMeasure>
    <ram:TotalGrossWeightMeasure unitCode="KGM">23</ram:TotalGrossWeightMeasure>
    <ram:ConsignorTradeParty>
      <ram:ID schemeAgencyID="XXXXXXXXXX">3629039</ram:ID>
      <ram:Name languageID="XXXXXXXXXX">PAS F K EURAS A LOJ ST K DI T C. A</ram:Name>
      <ram:LanguageCode listAgencyID="5">aa</ram:LanguageCode>
      <ram:DefinedTradeContact>
        <ram:ID>XXXXXXXXXX</ram:ID>
        <ram:PersonName>XXXXXXXXXX</ram:PersonName>
        <ram:DepartmentName>XXXXXXXXXX</ram:DepartmentName>
        <ram:TypeCode listAgencyID="6">EB</ram:TypeCode>
        <ram:AuthorizedPersonName languageID="XXXXXXXXXX" languageLocaleID="XXXXXXXXXX">XXXXXXXXXX</ram:AuthorizedPersonName>
        <ram:TelephoneUniversalCommunication>
          <ram:CompleteNumber languageID="XXXXXXXXXX">03122844772</ram:CompleteNumber>
        </ram:TelephoneUniversalCommunication>
        <ram:FaxUniversalCommunication>
          <ram:CompleteNumber languageID="XXXXXXXXXX">03122854780</ram:CompleteNumber>
        </ram:FaxUniversalCommunication>
        <ram:EmailURIUniversalCommunication>
          <ram:URIID schemeID="XXXXXXXXXX" schemeAgencyID="XXXXXXXXXX">g.ozer@pasifikeurasia.com.tr</ram:URIID>
        </ram:EmailURIUniversalCommunication>
      </ram:DefinedTradeContact>
      <ram:PostalTradeAddress>
        <ram:PostcodeCode>XXXXXXXXXX</ram:PostcodeCode>
        <ram:StreetName>Kizilirmak mah. Dumlupinar Bulv.No:3</ram:StreetName>
        <ram:CityName>Ankara</ram:CityName>
        <ram:CountryID schemeAgencyID="5">TR</ram:CountryID>
        <ram:CountrySubDivisionName>XXXXXXXXXX</ram:CountrySubDivisionName>
        <ram:BuildingNumber languageID="XXXXXXXXXX">3</ram:BuildingNumber>
      </ram:PostalTradeAddress>
      <ram:SpecifiedAuthoritativeSignatoryPerson>
        <ram:Name languageID="XXXXXXXXXX">XXXXXXXXXX</ram:Name>
      </ram:SpecifiedAuthoritativeSignatoryPerson>
      <ram:ApplicableLogisticsServiceCharge>
        <ram:CategoryCode listAgencyID="6">1</ram:CategoryCode>
        <ram:TransportPaymentMethodCode listAgencyID="XXXXXXXXXX" listAgencyName="XXXXXXXXXX" listName="XXXXXXXXXX" name="XXXXXXXXXX" languageID
        ="http://www.w3.org/TR/xmlschema-0/">XXXXXXXXXX</ram:TransportPaymentMethodCode>
      </ram:ApplicableLogisticsServiceCharge>
```

Source: Mr. Orkhan Namazov, ECE consultant.

Figure III
Guidelines for filling in the XML fields, in compliance with the UN/CEFACT standards, presented in a table

occurrence Min	Occurrence Max	MMT Business Name	MMT Dictionary Entry Name	MMT Definition	UNTDED Reference	CIM/SMGS Name (EN/RU)	CIM/SMGS Box No.	Example Notes	Country Usage: Azerbai	Geor	Kazakhs	Türki	Ukrai
0	1	Value Text	Document Context_ Parameter. Value. Text	The value, expressed as text, of this document context parameter.		код организации, контролирующее содержание сообщения							
0	**1**	**Version**	**Document Context_ Parameter. Specified. Document_ Version**	**The document version specified for this document context parameter.**									
0	1	ID	Document_ Version. Identification. Identifier	The unique identifier for this document version.		тип сообщения							
0	1	Name	Document_ Version. Name. Text	The name, expressed as text, of this document version.		справочный номер сообщения (уникальный номер, присваиваемый отправителем сообщения)							
0	**1**	**Exchanged Document**	**BSP Master. Exchanged_ Document**	**The header document information for a use of this master message assembly.**									
0	1	ID	Exchanged_ Document. Identification. Identifier	The unique identifier of this exchanged document.	(1004)	Идентификация отправки					x		
0	1	Type Code	Exchanged_ Document. Type. Code	The code specifying the type of exchanged document.	(1001)	Накладная ЦИМ/СМГС					x		
0	1	Status Code	Exchanged_ Document. Status. Code	document.	(1373)								
0	1	Issue Date Time	Exchanged_ Document. Issue. Date Time	The date, time, date time or other date time value for the issuance of this exchanged document.	(2007)	Дата заключения договора перевозки из накладной, оформленной на основную часть груза, условные данные					x		
0	1	Language Code	Exchanged_ Document. Language. Identifier	A unique identifier for a language used in this exchanged document.	[3453]								
0	1	Purpose Code	Exchanged_ Document. Purpose. Code	A code specifying the purpose of this exchanged document, such as request or reminder.	(1225)	Original of the consignment note	I				x		
0	1	Amendment Purpose Code	Exchanged_ Document. Amendment_ Purpose. Code	A code specifying a purpose of an amendment to this exchanged document.	(1225)	Статус перевозки в соответствии с Рекомендациями ООН №24 = X:							
0	unbounded	Amendment Purpose Text	Exchanged_ Document. Information. Text	Information, expressed as text, for this exchanged document.	(4142)								
0	1	Sender Assigned ID	Exchanged_ Document. Sender Assigned_ Identification. Identifier	A unique sender assigned identifier for this exchanged document.	(1004)						x		
0	1	Recipient Assigned ID	Exchanged_ Document. Recipient Assigned_ Identification. Identifier	A unique recipient assigned identifier for this exchanged document.	(1004)						x		
0	1	Version ID	Exchanged_ Document. Version_ Identification. Identifier	The unique identifier for the version of this exchanged document.	(1004)						x		
0	**unbounded**	**Note**	**Exchanged_ Document. Included. Note**	**A note included in this exchanged document.**									
0	1	Content Code	Note. Content. Code	A code specifying the content of this note.	(4441)								
0	1	Content Text	Note. Content. Text	A content, expressed as text, of this note.	(4440)	Other information (non-binding on the carrier)	15	NOT FY : TOO IP HAMLE KOMPANI LTD. ABLAYHANA 3A, KASKELEN CITY, 040800, ALMATY REGION, KAZAKHSTAN FAX : +7 727 300 2894 MOBILE NO: + 7 701 765 23 75	x	x	x	x	
0	unbounded	Subject Code	Note. Subject. Code	A code specifying the subject of this note.	(4451)						x		
0	**unbounded**	**Reference Document**	**Exchanged_ Document. Reference. Referenced_ Document**	**Other documents referenced by this exchanged document.**									
0	1	Type Code	Referenced_ Document. Type. Code	The code specifying the type of referenced document.	(1001)	Documents attached by the consignor	9	the trading pier of JSC KTZ Express for the KMTF feeder - JSC KTZ Express.KTF NO: 22041900GC100021 BEYANNAME: 22410100EX00000966 The wagon does not belong to the carrier. Own park. After unloading, empty wagons should be registered at the Altynkol station. On the territory of Georgia, Azerbaijan on inventory wagons. After unloading, the wagons are handed over to the carrier. The execution of the transit declaration for the kzh is carriedout by JSC"KTZ Express""KTZE-Zapadny".	x		x	x	
0	1	ID	Referenced_ Document. Identification. Identifier	A unique identifier for this referenced document.	(1004)	Номер договора							
0	1	Reference Type Code	Referenced_ Document. Reference_ Type. Code	The code specifying the reference type of this referenced document.	(1153)								
0	1	Date / time / period	Referenced_ Document. Formatted_ Issue. Date Time	The formatted date or date time for the issuance of this referenced document.	(2379)								

Source: Mr. Orkhan Namazov, ECE consultant.

Under the UNECE-UN/CEFACT-TRACECA pilot project, the consultant prepared a mapping between the CIM/SMGS consignment note and the UN/EDIFACT IFTMIN message used for the SMGS in a number of countries in the region, based on the UN/CEFACT Multimodal Transport Reference Data Model (MMT RDM) as the common reference and foundation for interoperability. This mapping is meant to serve as a foundation for a converter between the widely used in the Eurasian space UN/EDIFACT messages (IFTMIN and other messages) and new Internet-based technologies, such as XML, JSON, APIs and blockchain. Further, mapping to the MMT RDM can serve as the basis for digital interoperability between many documents in the supply chain, including in multimodal transport.

Figure IV
MMT RDM mapping between the CIM/SMGS consignment note and UN/EDIFACT message IFTMIN under the UNECE – UN/CEFACT – TRACECA pilot project

Mapping

Model: CIM-SMGS Consignment Note
Standard: UN D.23A
Guide: **32166039**

No	Length	Occurrence	Element	SeN	Se	CDE	DE	St	Format	Example
001		0 .. 1	**ID** *Path:* BSP Master. Details/BSP Master. Exchanged_ Document/ Exchanged_ Document. Identification. Identifier *(1004)*	2	**UNH**	**S009**	**0065**	M	an..6	IFTMIN *Path:* IFTMIN.UNH.S009.0065(0010:020:01)
002		0 .. 1	**ID** *Path:* BSP Master. Details/BSP Master. Exchanged_ Document/ Exchanged_ Document. Identification. Identifier *(1004)*	2	**UNH**	**S009**	**0057**	C	an..6	OSJD *Path:* IFTMIN.UNH.S009.0057(0010:020:05)
003		0 .. 1	**ID** *Path:* BSP Master. Details/BSP Master. Exchanged_ Document/ Exchanged_ Document. Identification. Identifier *(1004)*	3	**BGM**	**C106**	**1004**	C	an..70	10041228 *Path:* IFTMIN.BGM.C106.1004(0020:020:01)
004		0 .. 1	**Type Code** *Path:* BSP Master. Details/BSP Master. Exchanged_ Document/ Exchanged_ Document. Type. Code *(1001)*	3	**BGM**	**C002**	**1001**	C	an..3	722 *Path:* IFTMIN.BGM.C002.1001(0020:010:01)
005		0 .. 1	**Issue Date Time** *Path:* BSP Master. Details/BSP Master. Exchanged_ Document/ Exchanged_ Document. Issue. Date Time *(2007)*	1	**UNB**	**S004**	**0017**	M	n8	00230906 *Path:* UNB.S004.0017(040:01)
006		0 .. 1	**Issue Date Time** *Path:* BSP Master. Details/BSP Master. Exchanged_ Document/ Exchanged_ Document. Issue. Date Time *(2007)*	1	**UNB**	**S004**	**0019**	M	n4	1056 *Path:* UNB.S004.0019(040:02)
007		0 .. 1	**Issue Date Time** *Path:* BSP Master. Details/BSP Master. Exchanged_ Document/ Exchanged_ Document. Issue. Date Time *(2007)*	4	**DTM**	**C507**	**2380**	C	an..35	202309051309 *Path:* IFTMIN.DTM.C507.2380(0050:010:02)
008		0 .. 1	**Purpose Code** *Path:* BSP Master. Details/BSP Master. Exchanged_ Document/ Exchanged_ Document. Purpose. Code *(1225)*	3	**BGM**		**1225**	C	an..3	4 *Path:* IFTMIN.BGM.1225(0020:030)
No	**Length**	**Occurrence**	**Element**	**SeN**	**Se**	**CDE**	**DE**	**St**	**Format**	**Example**

Legend: No=Consecutive Number, SeNo=Segment Number, Se=Segment, CDE=Composite Data Element, DE=Data Element, St=Status
Status indicators: M=Mandantory, C=Conditional, R=Required, O=Optional, D=Depending, A=Advised, N/X=Not used

CIM-SMGS Consignment Note <--> 32166039_SMGS Print date: 28-Mar-24 Page: 1 /

Generated by GEFEG.FX

Source: Mr. Orkhan Namazov, ECE consultant.

3. Lessons learned

Among the achievements of the project were the development of a prototype of an electronic equivalent of the CIM/SMGS railway consignment note, in compliance with the global, UN/CEFACT standards and MMT RDM. The project resolved data mapping challenges for seamless integration between SMGS and CIM/SMGS, building on international and cross-institutional collaboration, refining the CIM/SMGS prototype with feedback from partners. The impact on multimodal transport is that the prototype supports future integration and interoperability of information exchange on cargo in multimodal transport, enabling efficient data sharing using global standards.

The next steps include extensive testing of the CIM/SMGS prototype and continued improvements, based on feedback. This would imply further customization of the standards and integration of the data in the prototype with national railway information technology systems, building converters between different solutions, using the UN/CEFACT standards as a common foundation.

Further steps would involve essentially multimodal pilot tests – involving seamless data exchange between the railway consignment notes and documents accompanying goods in other modes of transport. Implementers may explore integration of the data exchange into global supply chains.

One of the lessons learned from the project is the need for a legal basis for action on each stage of the pilot implementation project. The CIM/SMGS pilot project included a memorandum of agreement among the five railway operators in the five countries, expressly stating their willingness to participate in the pilot. Another necessary agreement would be on the functional implementation of the exchange of electronic datasets (electronic records) in place of the data exchanged in the consignment notes.

B. ETRAN (ELECTRONIC CONSIGNMENT NOTE) – SUBMITTED BY RUSSIAN FEDERATION

KEYWORDS: INTEROPERABILITY, ETRAN, DIGITALIZED DATA EXCHANGE

1. Objective

ETRAN is an automated system for the preparation and execution of transportation documents for rail freight transportation by Russian Railways across the territory of the Russian Federation. The purpose of the ETRAN system is to use electronic document management to interact with users of railway transport services in the organization of cargo transportation. The functions of ETRAN are implemented in terms of preparation, execution and review of transportation documents, master planning, provision of contractual work and calculation of freight charges and transportation distances, technological and technical support using electronic signature tools at the workplaces of ETRAN users.

2. Application, benefits and costs

Advantages:

- The life cycle of documents takes place in the system in paperless form;
- Costs for the preparation and delivery of documents are reduced;
- Planning costs by pre-calculating the cost in the submitted application;
- Possible errors in the calculation of the freight charge are excluded;
- Independent execution and control of all shipping documents;
- Safe and comfortable user experience, regardless of the Client's location.

The main package of services of ETRAN is as follows:

- Submission of an application for the transportation of goods and control of fulfilment;
- Execution of all waybills for the transportation of goods;
- Control over the availability of funds on the Service User's Unified Account;

- Tracking of the entire shipment, including to the address of the user of transport services from the entire network of the Russian Federation;
- Payment for transportation for other shippers (forwarding);
- Electronic signature of the shipper's representative responsible for the placement and securing of the cargo;
- Tracking Projected Shipment Arrival Times;
- Registration of applications for the placement of rolling stock not involved in the transportation process on public tracks;
- Receipt of acts of services rendered, list of primary documents for acts of services rendered and invoices;
- Submission of applications for the diversion of wagons;
- Information service services;
- Calculation of freight charges.

The ETRAN system is the first centralised real-time document processing system at Russian Railways. When designing the architecture of the software and hardware complex of the system, the requirements of reliability and uninterrupted operation in the 7x24 mode were taken into account.

3. Lessons learned

To date, more than 40,000 users from 11,000 organisations have been connected to ETRAN, including 17,500 users from 8,000 client enterprises that are not divisions of Russian Railways.

During periods of maximum activity, there are up to 10 thousand concurrent users in the system. More than five million electronic documents are issued per month, including over 136 thousand applications and more than 1.6 million invoices.

To date, the full technological cycle of the formation of documents in accordance with the Rules of Cargo Transportation has been automated (application for the transportation of goods, transportation documents (consignment notes) of all types, including international ones, for departure on the basis of an application, credited documents upon arrival, etc.).

ETRAN is the only system that automates the entire process of sales of basic and related services and settlements with customers in the course of cargo transportation.

C. ELECTRONIC INTERACTION WITH FOREIGN CARRIERS – SUBMITTED BY RUSSIAN FEDERATION

KEYWORDS: INTEROPERABILITY, UN/EDIFACT, SMGS, CIM, CONSIGNMENT NOTE, CUSTOMS CLEARANCE

1. Objective

Russian Railways, in cooperation with foreign railways, implements projects for electronic interaction and information support of international rail freight transportation, aimed at exchanging data in the international standard UN/EDIFACT of traffic documents (SMGS, CIM/SMGS, train information) in real time for the transportation of export-import goods by rail.

Electronic interaction in international freight transportation is carried out on the basis of the concluded Agreements on Electronic Data Interchange (hereinafter referred to as the EDI Agreement).

Electronic data interchange facilitates border crossings by providing electronic information in advance about the cargo to be crossed.

2. Application, benefits and costs

At present, there are bilateral EDI Agreements between Russian Railways and the railway administrations of Azerbaijan, Belarus, China, Estonia, Kazakhstan, Kyrgyzstan, Latvia, Lithuania, Mongolia, and Poland as well as a trilateral EDI Agreement between Russian Railways, DB (Germany) and DB CARGO Polska (Poland).

Russian Railways interacts electronically with the Federal Customs Service of the Russian Federation (hereinafter referred to as the FCS of Russia), including the following functionality:

- Preliminary informing of the customs authorities in electronic form about the cargo (goods) planned to cross the border, and electronic registration of the arrival of the cargo at the border station;
- Receipt of export declarations for exported goods and information from the transit declaration from the unified automated system of the Federal Customs Service of Russia;
- Completion of the customs procedure of customs transit on the territory of the Russian Federation in electronic form without delivery of paper documents to the customs authorities.

For export rail transportation, electronic marks are obtained from the customs authorities, confirming the export of goods from the territory of the Russian Federation for all international transportation. Russian Railways receives from the Federal Customs Service of Russia electronic analogues of the customs authorities' marks, indicating that goods have been placed under procedures that provide for their export outside the Eurasian Economic Union, for all export shipments, both on electronic consignment notes and on paper.

Russian Railways and the Federal Tax Service of the Russian Federation have organised data exchange to enable the tax authorities to submit to the tax authorities the information on the railway consignment notes required to confirm the 0 per cent VAT rate in electronic form.

3. Lessons learned

In terms of implementing informational interaction for import transportation, the system has been designed to provide preliminary information about planned shipments, handle notifications to customs authorities for registering the arrival of goods at the border station and the destination station. The customs transit procedure is completed electronically, eliminating the need to deliver paper documents to customs authorities after the goods arrive at the destination station.

The introduction of electronic interaction has reduced costs for railway carriers involved in international cargo transport, decreased the workload on railway and customs personnel for customs control and clearance, and created favourable conditions for participants in foreign economic activity.

Electronic Document Exchange enables the creation of a unified informational space within the railway network and provides tools for electronic document flow with foreign railways, partners, clients using railway transport services, and, importantly, with government and regulatory bodies.

D. INTERTRAN – SUBMITTED BY THE RUSSIAN FEDERATION

KEYWORDS: INTEROPERABILITY, INTERTRAN, CUSTOM CLEARANCE, DIGITALIZED DATA EXCHANGE

1. Objective

The INTERTRAN project was initiated by Russian Railways in 2018. FESCO Transportation Group became a partner in the project. It has received the support of key international organizations - the EEC ITC and UNESCAP, OSJD, UIC, CCTT, FIATA.

INTERTRAN is a comprehensive project for the implementation of intermodal transportation with the issuance of electronic documents, in which the operator of the sea line, the carrier represented by Russian Railways, customs authorities, shippers and consignees take part.

The created INTERTRAN information technology contains specifications for processing the operations of transportation participants in its information systems, which form a single information environment for each transportation.

2. Application, benefits and costs

INTERTRAN is the first information technology in history that enables intermodal transport in a fully digital format.

The technology developed within the framework of INTERTRAN to close the customs procedure of customs transit in electronic form at the destination station is currently used at all Russian Railways stations working with containers. Application, benefits and costs

The introduction of INTERTRAN has contributed to the development of all import transport under the VTT regime. According to the technology, 95 per cent of import cargoes are cleared in the VTT mode through the port of VMTP. 50 per cent of the total volume of shipments processed via VTT through the port of VMTP using the INTERTRAN technology.

3. Lessons learned

The results of the analysis of transportation showed that the implementation of digital technologies and automation of operations for the execution of documents within the framework of the INTERTRAN project at all stages of intermodal transportation made it possible to reduce the total time of cargo clearance by four days due to the transfer of applications to electronic form, the introduction of mobile workplaces for acceptance agents and tallymen in the port, electronic interaction with customs authorities, as well as by reducing unproductive losses related to the movement of employees for the execution of customs, transportation documents and primary documentation, both at the port and at the destination station.

As a result, a modern information and logistics service has been formed, which makes it possible to accompany the transportation of a container of any freight forwarder or operator with electronic data along the entire route, to provide the necessary electronic information not only to interested parties, but also to state regulatory authorities.

E. TRANSLATE4RAIL – SUBMITTED BY UIC

KEYWORDS: INTEROPERABILITY, INTERTRAN, CUSTOM CLEARANCE, DIGITALIZED DATA EXCHANGE

1. Objective

TRANSLATE4RAIL was an EU supported project (Shift2Rail Programme) under coordination of UIC and with project partner RailNetEurope to develop technological means that could assist at overcoming language barriers during international rail freight transport in which intermodal transport is a very important part.

Rail freight and its future rely heavily on cross border exchanges. In this context corridors support a seamless approach for the rail freight offering. Nonetheless interoperability barriers still exist, such as high-level language proficiency requirements. These language requirements are key in safe rail operations and are needed to ensure unambiguous communication between railway operators and traffic control but they do however make the necessary training of locomotive drivers even more difficult. Allowing greater flexibility in terms of language requirements without jeopardizing safety is a priority.

A first objective of TRANSLATE4RAIL was to provide drivers and traffic controllers with a set of predefined messages for usage in normal, degraded and emergency operational circumstances. As a second objective these messages would need to be embedded into a digital tool on which communication could be established. Last, the developed tool was tested in a pilot environment in different corridors.

2. Application, benefits and costs

This tool has many advantages. It improves:

- Reliability: the digitally assisted communication will help the driver to follow better communication disciplines defined by the European Technical Standards for interoperability (TSI OPE). Tests have shown that having an assisting tool, increases confidence of the drivers in the operational communication.
- Capacity: The communication could take longer time but the cross border procedure could be done more efficiently and would reduce idle and wasted time for change of drivers.
- Efficiency: In the future other language requirements to the drivers could be considered meaning that the pool of drivers could be enlarged.

The project benchmarked state of the art examples of speech-to-speech technologies (within the rail and outside the rail industry). Furthermore, the functional and technical requirements for a language tool were defined. All safety aspects were thoroughly investigated and guidelines for implementation in a test environment were developed.

Safety is one of the major topics within rail freight business. A concept of "Safety by Design" was applied Therefore a mapping was developed that assessed all situations needing communication between drivers and signallers and predefined messages where defined for normal, degraded and emergency situations. The translations were done and checked by operational and bilingual experts consisted of following steps:

- Is the mapping of situations exhaustive?
- Are the messages written in a way that excludes any ambiguity in the translation?
- Is the voice recognition reliable?
- Is the transcription from voice to text reliable?
- Is the translation reliable?
- Is the conversion into voice-over reliable and usable?

3. Lessons learned

The overall objectives of the project were reached:

- For structural and safe communication indeed a list of predefined messages can be developed, also within a rail context. Hence it was proven that rail operations do not differ from other modes of transport (e.g. airline operations) on that level.
- It is possible to integrate a tool (tablet) into a driver cabin which complies to all legal requirements.
- The project even showed that pilot testing is possible if all stakeholders work together to reach one goal.
- We saw indeed that under pilot circumstances the speed of communication improved significantly (especially after some adjustments between the 1st and 2nd pilot).

- The project was a good basis for further development like the extension with other languages.

The project showed that it is indeed possible to develop digital tools which can assist operations to overcome language barriers. A number of technical enhancements are needed to move from a pilot into real life operation:

- The predefined messages do need to take into account national rules as well. Even within one language national differences can exist. During the tests this was already done but further improvement is possible.
- Having shorter messages made transmission easier.
- Tool functional enhancements to reach a robust and stable solution ready for fully operational situations.

Next steps that can be developed are into free speech recognition and extension of the number of pre-defined messages.

The biggest challenge to this type of technological evolutions is probably the human factor. Without involvement of labour representatives from the start these kinds of evolutions can be perceived as a threat rather than a help. Absolute care should be taken on stakeholder management to avoid it is being pushed back as job threatening. In the context of rail freight these tools should rather be positioned as a partial solution to job shortages and further improvement of job quality rather than job destructive.

IV. OTHER SOLUTIONS AND CASE STUDIES

A. STUDY: JOB PROFILES AND OPPORTUNITIES FOR EMPLOYMENT IN AN AUTOMATED AND DIGITALIZED AUSTRIAN MOBILITY SECTOR 2040 – SUBMITTED BY AUSTRIA

KEYWORDS: HUMAN RESOURCES, HUMAN-CENTRIC, RETRAINING, UPSKILLING

1. Objective

Against the background of increasing automation and digitalization, this study looked at the emerging and coming changes in the job profiles relevant to the Austrian mobility sector up to the year 2040, as well as the resulting opportunities and risks for employment and quality of work. The study aims at increasing automation and digitalization in the mobility sector, in particular at emerging and upcoming changes in the job profiles relevant to the mobility sector by 2040, as well as the resulting opportunities and risks for employment. It fills a (still) existing gap in knowledge, as there have been hardly any studies on the subject of employment effects in an increasingly digitalized and automated mobility sector. For the analysis, three scenarios ("Forward 2040", "Local Life", "Digital Divide") were developed with a time horizon of 2040, which were discussed and evaluated with a wide range of stakeholders from all modes of transport as well as freight and passenger transport. The discussion and evaluation of the three partly contradictory scenarios illustrated many parallels between the scenarios, so that a cross-scenario overall picture could be drawn for the future of employment, job profiles, skills, quality of work and gender in the mobility sector. From these findings, concrete areas of action for politics and interest groups (mobility and transport policy, RTI policy, labour market and social policy, education policy) as well as for companies were derived.

2. Application, benefits and costs

The studies "Job profiles" and "SozA" are finished and have been used as input for other R&I-projects as well as national roadmaps and strategies but also for discussion with the public and specific groups, which have been addressed in the studies. There are no further activities planned.

3. Lessons learned

Both studies "Job profiles" and "SozA" gave an excellent overview about challenges, hurdles and necessary actions. However, based on the results and the high dynamic behind the evolvement of the technology, it would have been necessary to update the results on a regular base (e.g. every year). This seems not efficient as it is still not clear how automated transport will look like. Much more it makes sense to start with the evaluation on an European level to enable a comparison of results an data instead on focussing on national levels. In this respect Austria is actively participating within the CCAM-Partnership, the SRG (States Representative Group), the HLD (High Level Dialogue on Connected and Automated Driving) to discuss the impact on employment on a European level.

B. TEST TRACK DIGITRANS (TEST TRACK FOR AUTONOMOUS DRIVING IN ST. VALENTIN) – SUBMITTED BY AUSTRIA

KEYWORDS: AUTONOMOUS DRIVING, DIGITRANS

1. Objective

The Austrian Test environment Digitrans enables testing of automated driving functions under various infrastructural conditions. The focus is on automated and autonomous vehicles and mobility systems in the field of municipal services, logistics and heavy goods traffic.

2. Application, benefits and costs

The classic test elements of the already existing proving ground, such as asphalt tracks with different road markings, bad road tracks, twisting tracks, off-road terrain, different gradients and circular tracks will be expanded by 2023 to include further important ODD elements and the necessary digital infrastructure (C-ITS / 5G). In total, around seven zones for testing autonomous vehicles and transport vehicles in the heart of Europe will be available on the autonomous driving proving ground in St. Valentin by 2023.

In total over €6 million have been invested for the development of a city zone, an outdoor raining facility, digital infrastructure as well as components for simulation and validation. The test track is used by OEMs, R&I-institutes, startups from all over the world to test their applications. Especially the outdoor raining facility is in its specification unique and hence attractive for companies to test their advanced driver assistance systems as well as highly automated vehicles. Additionally, the test track can be used for human-machine-interaction trainings and teleoperation.

3. Lessons learned

Test environments are crucial for the further development of automated freight mobility solutions. Technology is still not ready yet and has to be further improved. It's not possible to cover any situation with one test track as technology is evolving fast. Hence test tracks have to be evaluated every year if changes are necessary and if the facilities meet the requirements. The most critical part is data management as the results have to be interoperable being used by different test tracks not only in one country but over the world and by including all different stakeholders. This might be the most challenging task. Beside that the involvement of the infrastructure operator (e.g. road operator) is crucial for the development and deployment of automated trucks.

Handbook on Digitalization and Automation in Intermodal Freight Transport

Despite the environmental benefits of intermodal transport, where railways serve as the main mode, road transport remains the dominant choice for freight in many regions. This underutilization of intermodal options can be attributed to factors such as the often longer delivery times, reliance on traditional paper-based information systems in some areas, and the absence of interoperable digital standards.

Technological advancements present opportunities to address these challenges. Digitalization in freight transport could transform traditional analogue information and processes into digital formats, enabling streamlined information exchange. With this digital foundation, many processes in intermodal transport can be automated, and when managed correctly, digitalization and automation can enhance the reliability, efficiency, and cost-effectiveness of intermodal transport.

However, cybersecurity remains a significant concern, as potential cyber threats could disrupt operations or compromise sensitive data. Ensuring cybersecurity is essential for system stability and business continuity, thereby supporting the resilience of digitalized intermodal freight systems. Additionally, it is important to ensure that digitalized information is interoperable across systems for a seamless and efficient transport chain. Last but not least, a human-centric approach to digitalization and automation is vital to ensure that the benefits of technological advancements are shared equitably among stakeholders and that support is provided for those adversely affected.

This handbook offers guidance and a starting point for stakeholders interested in digitalizing and automating intermodal transport, highlighting the benefits of improved efficiency, safety, and job quality, as well as the importance of a human-centric approach in implementing these changes.

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