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List of Acronyms

Abbreviation/acronym	Description
AEVs	Autonomous Electric Vehicles
ATL	Atlantic Core Network Corridor
B2A	Business to Administration
B2B	Business to Business
BRI	Belt and Road Initiative
CEF	Connecting Europe Facility
CESM	Community Earth System Models
CIMIS	Croatian Integrated Maritime Information System
CLC	China Railway Corporation
CNC	TEN-T Core Network Corridor
DCSA	Europe, or the Digital Container Shipping Association
DLT	Distributed Ledger Technology
DSS	Decision Support Systems
DTLF	Digital Transport and Logistics Forum
EC	European Commission
ECA	Extra Container Capacity Antwerp
EDB	Eurasian Development Bank
EEU	Eurasian Economic Union
eFTI	Electronic Freight Transport Information
EMSA	European Maritime Safety Agency
EMSW	European Maritime Single Window
ENMSW	Electronic Maritime Systems for Ports
ERTMS	European Rail Traffic Management System
ESPO	European Sea Ports Organisation
ETA	Estimated Time of Arrival
EU	European Union
GHG	Greenhouse Gas
HC	High Cube
HHLA	Hamburger Hafen und Logistik AG
HVCC	Hamburg Vessel Coordination Center
ICT	Information and communications technology
IMO	International Maritime Organisation
IMP	Import Message Platform
IOS	Inter Organisational Systems
IoT	Internet of Things
IPCSA	International Port Community System Association
ITF	International Transport Forum
ITF	International Transport Forum
KPI	Key Performance Indicator
M2M	Machine-to-Machine
M2P	Machine-to-Person
MED	Mediterranean Core Network Corridor
MoS	Motorways of the Sea
MTO	Multimodal Transport operator
NEP	Northeast Passage

NMSW	National Maritime Single Window
NSB	North-Sea Baltic Core Network Corridor
NSMED	North-Sea Mediterranean Core Network Corridor
NSR	Northern Sea Route
NWP	Northwest Passage
P2P	Person-to-Person
PCS	Port Control System
PEP	Port Environmental Performance
PSC	Port State Control
RALP	Rhine-Alpine Core Network Corridor
RCP	Representative Concentration Pathway
RFD	Reporting Formalities Directive
RIS	River Information Services
RTG	Rubber Tyred Gantry Crane
SCAN-MED	Scandinavian-Mediterranean Core Network Corridor
SESAR	Single European Sky ATM Research
TEN-T	Trans-European Transport Network
TEU	Twenty Foot Equivalent
TPR	Transpolar Route
TRAN	Committee on Transport and Tourism
TSR	Transpolar Sea Route
UN	United Nations
UN/CEFACT	United Nations Centre for Trade Facilitation and Electronic Business
UNECE	United Nations Economic Commission for Europe
VTMIS	Vessel Traffic Management Information System
WBIF	Western Balkan Investment Framework
WCO	World Customs Organization
WTO	World Trade Organization

Executive Summary

The findings presented herein derived from the analysis done regarding all the ports involved in ePIcenter, as well as the impacts of new Silk and Arctic Routes on the existing TEN-T Corridors and corresponding multimodal transfer zones. This document also reports on the standardisation aspects of the project as well as co-operation with standardisation bodies and policy recommendations.

ePIcenter focuses on analysing the impacts of global supply chains, taking into account emerging transport modes and important global trade routes, such as the Silk and Arctic Routes, aiming at achieving a more efficient and sustainable multimodal freight transport system and logistics. In this context, the project will present the general goal of making better use of digital solutions on transport connections, especially port hinterland connections. It is also important to bear in mind that the digital layer of transport infrastructure is not disconnected from the physical layer and can make the transport supply chain more efficient.

Notwithstanding, although the TEN-T Regulation focuses on digitalisation, a greater importance should be placed on the digital infrastructure layer. However, stakeholders have widely recognised that the EU Regulation on electronic freight transport information (eFTI) has already enabled more efficient multimodal logistic chain operations, ensuring the harmonisation and establishment of an EU framework for existing freight information, while also encouraging the use of electronic documents.

On the one hand, the present report shows that ports fulfil an important role in trade development and as gateways of a multimodal network. They are of major relevance as digital hubs, having taken significant strides for a strong digital transport infrastructure.

On the other hand, findings show that, as a result of the Silk Route, scheduled connections between the Port of Duisburg and terminals in China have resulted in an extremely reliable option for the exchange of goods and more. Such reinforces the potential of the Arctic Route as a transoceanic maritime route, though in the long-term rather than in the near future.

In order to ensure that ePIcenter's activities will take into account the impact on the TEN-T and the new global routes, the present report also reflects on KPIs that can be considered to measure how ports can be more efficient and digital, especially with regards to their hinterland connections. These KPIs will be further developed, but they can already be indicative of how the TEN-T, the new global routes, digital port operations and port hinterland connectivity are linked to ePIcenter.

The establishment of ports as logistic and intermodal hubs is paramount. Port capacity is translated into economies of scale that enable cost reductions. Moreover, maritime and land connectivity represent key aspects of competitiveness. In this regard, land connections, and especially rail connections, remain the Achilles heel of European ports. Besides, the ports of the future need to ensure more digital information and data sharing, allowing smoother and more efficient day-to-day operations, with more seamless intermodal connections to important global hubs.

1 Introduction

1.1 Methodology review

This document is intended to collect information from many different sources to be presented in a single report, which can be used by ePIcenter partners as a useful guide for future work and progress in the project, especially concerning the development of use cases and their impact on the sections of the TEN-T. Therefore, the document contains many extracts from other previously published articles, which have been edited and collated, including reflecting important data of ports inserted within ePIcenter and findings from the evaluation of the TEN-T Regulation, as well as results from stakeholder consultations thereof.

This report provides an overview of initial ePIcenter deliverables, and how their findings reflect on initial TEN-T and global networks recommendations. The report then provides an overview on issues which are relevant to highlight important recommendations, especially to reflect on KPIs that can be incorporated in the ePIcenter use cases.

During the draft phase, the report will be forwarded to other consortium partners, serving a double purpose. Firstly, it will enable the inclusion of other relevant contributions with respect to their activity. Secondly, it will enable the validation of the information already integrated in the report. This exercise culminates in the last round of contributions to finalise the report.

It is also worth noting that the findings and recommendations presented herein shall be linked with ePIcenter's webinar on the TEN-T, to held in December. The webinar is expected to introduce the current work that has been undertaken within the project, bridging with issues connected to the TEN-T, especially concerning the revision of the current TEN-T Regulation.

1.2 Lessons stemming from D1.2, D1.3 & D1.4

This deliverable is an extension and continuation of the work carried out in Deliverables D1.2: TEN-T & Global Networks – Initial Review of Challenges, D1.3: Arctic and New Trade Route Challenges, as well as D1.4: Initial Stakeholder Requirements Analysis. The findings and conclusions stemming from the work developed in D1.2 are directly linked to the issues at stake in the present document, especially concerning the TEN-T network and impact of global routes on the TEN-T, and how these are linked to ePIcenter. Although D1.3 mostly discusses the environmental impacts of the Arctic trade Route on marine life and ecosystems, some aspects regarded therewith can give food for thought on how the new Arctic Route is developing and what challenges it brings to port hinterland connections in Europe, especially in ports within the ePIcenter project. Finally, D1.4 discusses the initial requirements for the pilot demonstrations within ePIcenter (the Enride autonomous vehicles, the Hyperloop cargo solution at Volkswagen's plant in Wolfsburg, besides Arctic Routing and Propulsion algorithms). The initial requirements laid down in D1.4 may provide an overview on standardisation aspects that can be better aligned with the TEN-T requirements, especially with what concerns the hinterland connections.

The following paragraphs provide a brief summary of the findings from deliverables D.1.2, D1.3 and D1.4 which are relevant for the present report on the initial recommendations on the TEN-T and the global networks, especially concerning the issues at stake on the Core Network Corridors, the impact of new global routes on the TEN-T, as well as standardisation aspects.

D1.2: TEN-T & Global Networks Initial Review of Challenges

The analysis carried out in deliverable 1.2 highlights the overall objective of the TEN-T Regulation of closing gaps, removing bottlenecks and technical barriers, with a focus on high-quality infrastructure. TEN-T policy also supports the deployment of innovation, new technologies and digitalisation of all transport modes. Therefore, a strong focus has to be given on digitalisation, which is a strong focus of ePIcenter. This component can be closely linked with successful initiatives from the Commission, namely the Motorways of the Sea (MoS), which is integrated within the TEN-T, and the Digital Transport and Logistics Forum (DTLF).

Despite the strong TEN-T investments (i.e. through CEF funding) on improving hinterland connections, many seaports on the network still lack high-quality hinterland connections by rail, road or inland waterway transport. Hinterland connections are recognised to play an important role in promoting port competitiveness. In this regard, co-modality also strongly influences the efficiency of these connections, contributing to the expansion of port hinterland connectivity. Moreover, the development of TEN-T Core Network Corridors should aim towards the integration of maritime connections with other modes in the network. Although the quality and efficiency of such connections is often measured in terms of ports' connectivity to the rail network, the Staff Working Document on the revision of the TEN-T Regulation[1] already recognises that this might not be the best indicator to assess the quality of such links.

Enhancing multimodal transport can be achieved through optimal infrastructure integration and interconnection of all transport modes. Nevertheless, despite the focus on the physical layer of infrastructure, the digital layer also plays a prominent role on the network's operations. In particular, last-mile connections to ports can be made more efficient by deploying ICT solutions to simplify administrative processes, thus improving the performance of terminals in the wider logistics chain with the regard to time savings, reliability and security. The EU is supporting investments in ICT projects and including Single Windows applications to promote digitalisation. The implementation of an EU Maritime Single Window environment can facilitate data exchange in maritime transport, preventing unnecessary delays and ensuring more efficient maritime operations. In addition, the deployment of Sea Traffic Management can also improve the exchange of data and information between maritime institutions and authorities, as well as other stakeholders, with the goal of ensuring just-in-time maritime services.

Major projects such as ELETA30, which aims to demonstrate the benefits of exchanging Estimated Time of Arrival (ETA) data throughout the rail supply chain management, and FEDeRATED, aiming at reaching an interoperable infrastructure for the exchange of business and administrative data for freight transport and logistics, are good examples of EU-funded projects under the umbrella of the Digital Transport and Logistics Forum (DTLF) which address some of these issues. This is also aligned with ePIcenter's goals, which, among other aspects, aims at accelerating an efficient integration of the TEN-T network with global networks and a seamless integration in the soft layer, via secure international information flows and digitalisation.

Similarly, containers are being transformed by information technologies. The digitalisation of container operations and the diffusion of "smart containers", which enables additional information to be made available to carriers, terminal operators and cargo owners are good examples of applications of the Internet of Things (IoT). New technologies, digitalisation and big data have the potential to change the way cargo and traffic flows are organised and managed, as they generate business opportunities and pave the way for innovation, new services and disruptive business models. Furthermore, it enables cooperation between relevant stakeholders such as supply chain, contributing towards a better supply chain visibility, real-time management of traffic and cargo flows.

Sustainable solutions are essential for the development of both ports and surrounding urban areas. The minimisation of transportation costs is the key objective of traditional logistics models. Thus, that the layout of container terminals is a decisive player in the ports' efficiency and capacity. The ePIcenter project fits within the objective of reviewing the challenges that the multimodal containerised and large freight segment is facing, helping to identify solutions that can facilitate sustainable global trade by reducing congestion at multimodal nodes (especially at ports) and optimising operations across the TEN-T network.

Deliverable 1.2 also provides an overview on the new Global Routes and its effects on ePIcenter. For instance, findings from this analysis highlight that the Chinese Belt and Road Initiative (BRI) – the new Silk Route - has been especially relevant for the development of some Core Network Corridors, namely for the North-Sea Baltic Corridor (NSB). The NSB Coordinator has promoted various dedicated meetings on the subject, especially

[1] Commission Staff Working Document Evaluation of the Regulation (EU) N° 1315/2013 on Union Guidelines for the development of a trans- European transport network {SWD(2021) 118 final}, Brussels, 26.5.2021 SWD(2021) 117 final

discussing how the Corridor's nodes and infrastructure can meet the current and future expected BRI-related traffic. In this regard, the TRAN Committee has recommended to continue the partnership with China, promoting studies concerning specific TEN-T and BRI Corridors.

D1.3 Arctic & New Trade Routes Challenges

Deliverable 1.3 assesses the opportunities and challenges from Arctic shipping, highlighting the threats that the severe ice conditions have on shipping operations. The Arctic routes can be divided into the Northwest Passage (NWP), the Northeast Passage (NEP) and the Transpolar Route (TPR), although only the NWP is used in commercial operations and the TPR to be used in the future.

The Transpolar Route (TPR) is not a passage as such but a theoretical route of about 2800 NM (from Norwegian Sea to Bering Sea). Although the Transpolar Route is much shorter than the Northeast and Northwest Passages, it is presently inaccessible due to the presence of thick multiyear sea ice. However, some preliminary studies have pointed out the possibility of such route being used in the commercial shipping operations.

Previous analyses had predicted considerable traffic growth in Arctic routes, with "destinational" traffic being the major driver in Arctic shipping, while transit traffic still remains marginal. Compared with the Suez route, the navigation shortcuts via the Arctic waters can reduce traditional transit times between East Asia and Europe by about 10 days and lower navigational distance by 3,000-4,000 miles. As a result of unpredictability, seasonality and non-regularity of navigation due to icy conditions, Arctic Sea routes are possibly more economical for bulk cargo vessels than for container vessels, since the latter depend more on precise schedules for loading, shipping, and unloading to keep costs down.
Therefore, the main technical and operational challenges of Arctic shipping are associated with costs. For example, fuel navigation costs in icy conditions are higher than in open water navigation as ice causes additional resistance to the ship's hull, requiring the use of higher engine power. Moreover, Arctic shipping is often assisted by icebreakers, with an icebreaker often navigating in front of the assisted vessel (or vessels which proceed) in "convoy". However, the proximity between ice-breakers and assisted vessels may increase the risk of accidents, accounting to almost 20% of navigation accidents.

Although trans-Arctic marine transportation is on the rise, it is still far from being an outburst. Infrastructure and marine services must be set up to ensure safe, secure and efficient operations of trans-Arctic navigation.

D1.4 Initial Stakeholder Requirements Analysis

The specific ePIcenter stakeholder requirements define the requirements for the different ePIcenter modules (governance models and data sharing layer, visibility, synchromodal logistics algorithms and freight network configuration impact comparator), new emerging technologies (modular containers, Hyperloop, autonomous vehicles) and route planning (Arctic routing) addressed within ePIcenter. Therefore, D1.4 analyses the requirements for the demonstrators within ePIcenter: autonomous vehicles (T-pods); the Hyperloop; and Artic Route planning and AI-based propulsion algorithms; and modular containers (Connectainer).

The first requirement layer refers to the infrastructure layer. This encompasses all existing transport and production infrastructure, such as rail, waterways, roads, pipelines, factories, terminals and ports. Infrastructure for emerging technologies such as Hyperloop are also included in this layer. A second layer regards the service layer, which represents the transport from A to B carried out by vessels and other transport modes operating on the infrastructure. A third layer is the digital layer, which consists of the following 2 parts:

- The information layer, encompassing both historic and real-time data about the cargo and the service and infrastructure layer.
- The process layer: the digital infrastructure that processes information using supportive information and communications technology (ICT).

The ePIcenter project mainly focuses on the enhancement of the 'digital layer' working on the concepts of visibility, and optimisation as key elements that directly impact and improve the effectiveness, efficiency and environmental performance of current supply chain practices in domestic and global applications. In order to optimise supply chains, ensuring more efficiency and greener operations, there is a clear need to complete and integrate the digital information layer creating end-to-end visibility covering the available infrastructure and services operating on them.

Important general requirements to ensure optimised supply chains include strategic decision-making and network design for long-term planning, based on forecasting and simulation models for long-term planning on the design of the physical network for synchromodal planning. A "Synchromodal Network" includes the existing physical network including new potential routes/corridors (e.g. Silk route, Arctic route), hubs and innovations for which a synchromodal service is feasible (infrastructural layer). This network design primarily depends on the availability of infrastructure (for multiple modalities) and services (capacity) and the adequacy of cargo flow in a specific corridor. Therefore, an in-depth analysis of the hinterland transport market, including the market structure, shipment size and frequency of the goods flow between origin and destination nodes, would be needed.

Another important general requirement encompasses the simplification, standardisation and interoperability of data sharing, with several organisations currently working on standardisation issues in the transport sector. In May 2020, a new partnership was signed between IMO, the World Customs Organization, UNECE and the International Standards Organization to support the increasing maritime digitalisation. Other initiatives include the regulation on Electronic Freight Transport Information (eFTI) in Europe, or the Digital Container Shipping Association (DCSA) working on standards for container shipping.

Autonomous Electric Vehicles (AEVs) have the potential to meet the increasing demand for the transport of goods, addressing the issue of driver shortage and reducing transport emissions. As part of ePIcenter's demonstrator, Einride's solution is an all-electric autonomous Pod, providing Transport-as-a-Service as part of a fleet of vehicles that are coordinated by an intelligent Freight Mobility Platform. The solution addresses the main challenges now facing the transport industry: electrification to enable the decarbonisation of freight transport, as well as the removal of drivers and the driver's cab as a way to ensure the safe development of higher levels of autonomy. Requirements for its implementation include those for modes of transport in general related to cost, quality, safety, security, reliability and environmental and social sustainability.

The Hyperloop is a new mode of transport that could offer the solution to many challenges currently faced in transport. It could offer highly reliable, flexible, fast, energy efficient and environmentally friendly transport. High value objectives are expected to be achieved when using Hyperloop as a system to connect major freight hubs. Some of the objectives of Hyperloop include high reliability, increased speed, very high energy efficiency and the possibility of transporting goods without polluting the environment in an ecological, besides also an economically feasible new mode of transport. ePIcenter's demonstrator will assess the potential of Hyperloop to improve cargo-handling in the Wolfsburg site of Volkswagen. For modelling and simulating Hyperloop Transportation Networks, several inputs have to be collected, namely regarding network structure and infrastructural parameters. Requirements for Hyperloop also include those of any mode of transport. Besides those, specific requirements for Hyperloop relate to the impact of the vacuum and speed on transported goods.

On Arctic routing and propulsion algorithms, specific challenges of shipping in the Artic include ice resistance, ice loads, uncontrolled ice events, use of icebreaker assistance, ice-initiated accidents, ice conditions, cold weather, fuel consumption and environmentally sensitive areas. In the field of transit analysis, requirements involve the definition and feasibility of appropriate ship types, estimations of cost, speed, transit time and the environmental impact of a voyage taking into account seasonal variations. For real-time navigation and propulsion guidance, they include providing ship-specific navigation guidance for route selection; and the ability to minimise fuel consumption, time and environmental impact.

2 The Core Networks Corridors of the TEN-T & ePIcenter

2.1 Introduction

The TEN-T Regulation is a subset of two multimodal network layers, consisting of the comprehensive and core networks. The core network includes nine geographical corridors, considered of greater importance in terms of their long-distance transport flows and the prominence of their transport nodes (airports, sea and inland ports, as well as rail-road terminals), including: the Atlantic, Baltic – Adriatic, Mediterranean, North Sea – Baltic, North Sea ¬– Mediterranean, Orient/East – Med, Scandinavian – Mediterranean, Rhine ¬– Alpine and Rhine – Danube Corridors.

The TEN-T Regulation focuses on high-quality physical infrastructure, supporting the application of innovation, new technologies and digital solutions encompassing all modes of transport. Therefore, TEN-T policy brings a great importance not only to the physical but also to the digital layer of transport infrastructure.

As pointed out in the findings of the previous deliverables, the digital layer is entirely linked to the physical layer, though they are often not considered with the same level of importance. The digitalisation of existing infrastructure can enable more efficient transport flows. Nevertheless, despite the TEN-T Regulation's focus on digitalisation, a greater focus should be placed on the digital infrastructure layer. This limitation is expected to be overcome in the revised Regulation, which is expected to be adopted by 2023. Initial aspects of the revised Regulation are expected to be made public by the Commission in the end of 2021, which will feed the following deliverable D1.5, due in May 2022.

Maritime and inland ports are important nodes for the TEN-T, especially as every Core Network Corridor (CNC) starts or ends in a port. Ports fulfil an important role in trade development and as gateways of a multimodal network. They are of major relevance as digital hubs, having taken significant strides for a strong digital transport infrastructure. For many seaports, the weakest link is still its hinterland connections, especially due to the lack of adequate levels of rail, road or inland connections and due to congestion on these routes.

Among other aspects, ePIcenter focuses on analysing the impacts of global supply chains, taking into account emerging transport modes and important global trade routes, such as the Silk and Arctic Routes, aiming to achieving a more efficient and sustainable multimodal freight transport system and logistics, with the overall goal of creating new logistic concept and tools. Therefore, ePIcenter aims at better exploiting the potential of digital solutions along land transport connections, especially port hinterland connections, seeking an efficient integration of the TEN-T with global networks, besides a seamless integration of the digital infrastructure layer through secure international information flows and digitalisation.

Along the TEN-T, ePIcenter covers six of the nine CNCs: the Atlantic (ATL), Mediterranean (MED), North-Sea Baltic (NSB), North-Sea Mediterranean (NSMED), Scandinavian-Mediterranean (SCAN-MED) and Rhine-Alpine (RALP) Core Network Corridors. These Corridors are represented in the project by the Ports of Antwerp (NSB, NSMED and RALP), Algeciras (ATL and MED), Hamburg (NSB, OEM, SCAN-MED) and Duisburg (NSB and RALP). In ePIcenter, these TEN-T Corridors are connected to the global networks, via the Port of Duisburg to the Silk Route (under the One Belt Road Initiative) and the Arctic Route, via the North-Sea Baltic Corridor.

This chapter will discuss what are the main issues at stake in these CNCs included in ePIcenter, also taking stock of how these aspects impact and relate to the ePIcenter project. As this is a strong underlying issue of the project, this chapter will also provide an overview of topics related to digitalisation along the network and especially on seaports and their hinterland connections, taking into account how standardisation can play a role in reaching a more efficient and sustainable freight transport system and logistics. Moreover, we will also look into the impacts digital solutions might generate on the TEN-T network (particularly on these 6 CNCs), besides on new global routes such as the Silk and Arctic Routes.

2.2 Main TEN-T Core Network Corridor issues related to ePIcenter

Critical issues related to TEN-T seaports

The maritime sector is the most critical transport sector. Roughly 80% of all goods are transported by sea, and in terms of tons per kilometre travelled, shipping is the most efficient and cost-effective transport mode. The Trans-European Transport Network (TEN-T) is a large network consisting of 335 ports. EU-owned ships represent 41% of the global merchant fleet and trade on all oceans, serving markets all over the world.

The European Commission stresses that the optimisation of port services and operations can result in a number of TEN-T ports being able to handle or attract more cargo and passengers and obtain significantly higher performance with the existing infrastructure, thereby reducing the need for funding. For some trades in traditional ports, costs of ports and ports terminal operations can exceed 30% of the total door-to-door logistic costs[2].

The survey carried out for the evaluation of the TEN-T Regulation, under the scope of the case study on infrastructure standards and requirements, highlighted that maritime cross-border links are often disregarded. This point has also been raised in Motorways of the Sea Fora, highlighting the need to better recognise the cross-border character of ports and to underline the fact that ports bring trade to and from the whole world[3].

The wider role of ports aside from pure transport functions, particularly in their potential to aid in greening the wider economy, needs to be more prominently recognised within TEN-T policy. To this respect, several stakeholders in the evaluation of the TEN-T Regulation acknowledged that seaports should be naturally considered as cross-border nodes, as they enhance the connectivity with the wider hinterland, boosting the economy and leveraging sustainability of the transport and logistics chain. Therefore, respondents claimed that they should be prioritised on an equal basis with cross-border land transport infrastructure projects.

Short-sea shipping is an essential link in the European logistic chains. It also enhances the resilience of the transport sector by increasing the number of more sustainable transport and logistic solutions. However, results of the evaluation of the TEN-T Regulation also revealed that more attention towards short-sea shipping is needed. In addition, more efforts are needed to promote further modal shift from road transport to short-sea shipping.

Port hinterland connectivity

A functioning hinterland transport network is an important determinant of economic growth[4]. In this regard, the TEN-T aims at strengthening Europe's international competitiveness by improving the accessibility of certain regions. More specifically, the TEN-T core network aims at bridging the gaps between different national transport systems. Improved infrastructure is expected to have a significant impact on the ports' hinterland connectivity and transport efficiency[5]. In addition, the completion of TEN-T Corridors is expected to generate a strong multimodal network on selected routes, increasing the efficiency of international supply chains, promoting multimodal connections based on rail transport and contributing to the decarbonisation of logistics.

[2] Communication from the Commission – Ports: an engine for growth, 2013
[3] Secchi and Gili, July 2021: ISPI-McKinsey Report - The Global Quest for Sustainability: The Role of Green Infrastructure in a Post-Pandemic World, Ch. 6.5: The Contribution of Maritime Transport and Short-Sea Shipping to Sustainability
[4] Franziska et al, Hamburg Institute of International Economics Bremen's and Hamburg's port position: Transport infrastructure and hinterland connections within the North Range, 2015
[5] Biermann, Franziska; Wedemeier, Jan (2016): Hamburg's port position: Hinterland competition in Central Europe from TEN-T corridor ports, HWWI Research Paper, No. 175, Hamburgisches WeltWirtschaftsInstitut (HWWI), Hamburg

New hub and gateway seaports[6] can promote alternative routes and improve connectivity – occasionally in combination with alternative infrastructure such as inland waterways. Furthermore, a modal shift to rail freight can be stimulated by dry ports and seaports connected by rail[7].

Many ports are already focusing on the increase of rail transport, seeking transport cost reductions and aiming towards greater decarbonisation of hinterland connectivity[8]. Nonetheless, the Commission Staff Working Document on the TEN-T[9] stresses that both seashore and port-hinterland connections lack coherence and strong focus on multimodal connectivity in ports. The recent progress report on the TEN-T shows considerable developments on the network, as 89% of ports in the core network are connected by rail – a key requirement to ensure multimodality and promote more efficient hinterland connectivity. However, as the maritime dimension is expected to be reviewed under the new TEN-T policy, reinforcing decarbonisation of the transport sectors, besides the integration of shipping routes, ports and land corridors, this progress may need to be accelerated.

Delays in the maritime or hinterland section and late departure/arrival or cancellation of ship calls challenge the flexibility of all port stakeholders. Therefore, better communication and coordination between all stakeholders in the supply chain is more than ever necessary to ensure the optimal use of infrastructure, enabling a more seamless connection between transport modes and to avoid delays.

The MoS Coordinator[10] emphasises that for ensuring a seamless European Maritime Space, it is crucial to ensure smooth multimodal transport by fostering modal shift and promoting investments in connections to the hinterland, especially last-mile connections by rail and inland waterways, besides road when necessary. Although efficient hinterland connectivity is an important tool for port competitiveness, inland distances and connections remain a key variable influencing port choice, regardless of improvements in hinterland transport. Ports continue to dominate their captive contiguous hinterlands while competing with other ports for distant hinterlands, wherever distance tends to become less important over a certain threshold. As emerging new global trade routes change freight flows, infrastructure development in ports is expected to also focus on the main entry points to inland connections, which can put pressure on existing infrastructure. Therefore, it is important to ensure appropriate quality of intermodal services, connections and infrastructure.

According to stakeholders consulted in the evaluation of the TEN-T Regulation, the new definition of seaports should recognise that the role and function of ports are changing as a result of: new market realities (such as volume growth, scale increases); new societal challenges (climate, air pollution, noise, increasing urbanisation); new needs (digitalisation, automation, e-commerce).

In its position paper, the European Sea Ports Organisation (ESPO)[11] stresses the importance of modernising the existing TEN-T network, rather than only focusing on its completion. Such modernisation is of paramount importance to meet the challenges of environmental sustainability and transport digitalisation.

Therefore, ESPO argues that the greening and digitalisation of transport should be primarily defined by Europe's transport policy, and that the objective of the TEN-T Guidelines should mainly focus on providing the necessary infrastructure and facilities, recognising the requirements set in the relevant transport legislation. This is in line with the results from the case study survey carried out under the scope of the TEN-T Regulation, as over 70% of the respondents agreed that the revision of the TEN-T Regulation should set more ambitious requirements for digitalisation of transport flows from ports and their hinterlands. In addition, the MoS Coordinator stresses the importance of adopting digital tools throughout the industry, such as the digitalisation of trade lanes,

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[6] Gateways ports are considered those that are either the final destination or origin of a large share of cargo. These are often hub with or connected to large concentrations of populations or manufacturing production

[7] The Belt and Road Initiative: Impacts on Global Maritime Trade Flows Discussion Paper, 2020

[8] Port Competition through Hinterland Accessibility: The Case Of Spain, Alonso et. al (2019)

[9] Commission Staff Working Document Evaluation of the Regulation (EU) N° 1315/2013 on Union Guidelines for the development of a trans- European transport network {SWD(2021) 118 final}, Brussels, 26.5.2021 SWD(2021) 117 final

[10] Motorways of the Sea Detailed Implementation Plan (DIP) by European Coordinator Kurt Bodewig, June 2020

[11] Position of the European Sea Ports Organisation in contribution to the Public Consultation accompanying the Impact Assessment for the revision of the TEN-T Regulation (EU)1315/2013, April 2021

interoperable data sharing or Sea Traffic Management, which need to be fostered to ensure a smart European Maritime Space.

Digitalisation of port hinterland connectivity and the TEN-T

In this vein, ESPO stresses the importance of enhancing the digitalisation of the port ecosystem. Digitalisation has the potential to increase the efficiency, safety, security and environmental performance both in the port as well as in the whole transport and logistics chain. A more efficient supply chain brings significant gains for ports, which are important multimodal nodes and where maritime, road, barge and rail transport converge. According to ESPO, port managing bodies can have an important role in facilitating this digitalisation process, as they are considered "neutral matchmakers" between all parties involved in port operations, ranging from the ship-port interaction and hinterland connectivity. Port managers can also support the creation of data hubs and provide interconnectivity and digital services to stakeholders in the transport and logistic chain.

The COVID-19 crisis has given a boost to the digital transition in transport and logistics. It has showed that digitalisation can also be seen as an important tool in managing the health crisis. In this context, ESPO stresses that the short-term accelerated transition to paperless operations must be further consolidated.

Various actors in the logistics chain have already mobilised Important investments in ICT infrastructure. The findings from the dedicated case study on digitalisation in the scope of the evaluation of the TEN-T Regulation highlighted that gathering and exchanging real-time information among different parties in the logistics processes can be optimised and transport infrastructure can be used more efficiently. The expansion of the maritime sector and the entire transport sector pose increasing challenges to the smooth operation of the supply chain.

A key element towards making maritime transport smarter is the implementation of the EU Vessel Traffic Monitoring and Information System (VTMIS). The importance of digitalisation has also gained important recognition at EU level, with the EU Regulation on electronic freight transport information (eFTI) , which is extremely relevant for the overall multimodal logistic chain, mainly aiming at harmonising and establishing an EU framework for existing freight information, while also encouraging the use of electronic documents.

Information sharing offers a great potential to the maritime logistics sector. It can reduce costs, lower delivery times and present overall improvements in the overall port logistics chain. The maritime sector has already been harnessing data via digital technologies for greater insights into the logistics chain in order to improve logistics processes, especially through the development of the European Maritime Single Window (EMSW) which will be discussed further ahead.

Nevertheless, in order to maximise port throughput, it is important to work in boosting the interoperability of data and messages coming from different actors. The work under the Digital transport and Logistics Forum (DTLF), on ICT land systems in the ports' direct hinterland, such as federating networks of logistic chain stakeholders, is supporting those goals.

Profile of ports within ePIcenter and related TEN-T issues

The ports inserted within ePIcenter cross six TEN-T Core Network Corridors, having considerable impact on the entire network. The current TEN-T core network was established in 2013 and has since helped to strengthen and concentrate the position of important European ports, improving their infrastructure and developing main transport routes to/from ports.

In the North Sea region, ports have quite distinct infrastructures. Some are close to city centres (e.g. the ports of Hamburg and Antwerp) and hence particularly keen on reducing local emissions. Ports in the North Sea region play an important role on the global trade system. For instance, the Port of Hamburg, the largest in Germany and the third largest in the EU, links the SCAN-MED, OEM and NSB Core Network Corridors to Asian, Arabic, African, North and South American markets. As of 2016, roughly 1,100 freight trains per week and more than 7,000 logistics companies transferred goods shipped through the port via its hinterland[12]. This hinterland traffic showed considerable increase due to the willingness of the Port of Hamburg to shift an increasing amount of goods traffic in its hinterland from road to rail and IWT[13]. In 2019, the Port of Hamburg handled over 130 million tonnes of goods and 9 million TEUs[14].

The TEN-T's North Sea-Baltic Corridor (NSB) is a typically coastal Corridor, with various regular maritime ro-ro and container services. In this regard, maritime transport is an alternative on the longer distances between the North Sea and the Baltic Sea. As pointed out by the Corridor's Coordinator in her 4th Work Plan, the ports of the Corridor are among the busiest in Europe. Together, they handled 1.1 billion tonnes of cargo in 2018 (around 27% of all cargo transiting through EU ports), of which roughly 100 million tonnes are transhipment traffic (mostly Hamburg and Bremerhaven)[15]. The NSB is the Corridor with the second most important hinterland traffic volume, thus underlining the importance of ensuring strong port-hinterland connections, especially as such connections represent 90% of all cargo moved between ports and the Corridor sections.

The Port of Duisburg (inserted in the NSB and RALP) is the world's largest inland port and one of the leading logistics hubs in Central Europe, handling a cargo volume of over 110 million tonnes per year and 4.2 million TEUs. It is located in the heart of Europe's largest consumer market with more than 30 million consumers over a radius of 150 km[16]. With container shipping being part of the international logistical chain, 96% of waterside container traffic in Duisburg is international traffic (50% is export, and 46% import). Export traffic is mainly shipped downstream on the Rhine to the ARA seaports (Amsterdam – Rotterdam – Antwerp), and 77% of these export containers were loaded in 2016, and only 23% were empty[17]. This shows that inland waterway container traffic plays an important role for the exports of manufactured goods via the ARA seaports to overseas.

Also in the North Sea region, the Port of Antwerp (crossing the NSB, NSMED and RALP), a major international port and considered one of the main gateways to Europe, ranking 14th in the 20 largest container ports in the world. Thanks to its location 80 kilometres inland within Europe, Antwerp offers the fastest and most sustainable connection with the European hinterland. The volume of freight loaded or unloaded in Antwerp has doubled over the past 20 years to more than 238 million tonnes[18].

Being the crossing point of two CNCs (ATL and MED), the port of Algeciras provides the shortest sea distance and high-frequency services to/from Morocco. Algeciras is Spain's largest port in total volume (over 100 million tons) and the second largest container port in the Mediterranean (after Valencia), with a container volume of over 4.5 million TEUs[19]. Due to its strategic location in the south, the port of Algeciras is a transhipment specialist, albeit with a small amount of hinterland flows.

Together, the four ports inserted within ePIcenter handled over 591 million tonnes of freight and over 30 million TEUs of container traffic (Table 1). Despite the different profiles and characteristics of each port, they together represent a considerable share of TEN-T maritime traffic, with their activities impacting on the network's road, rail, inland waterway and maritime sections.

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[12] National Strategy for Sea and Inland Ports, German Federal Ministry of Transport and Digital Infrastructure (BMVI), 2016
[13] Annual Report 2017 Inland Navigation in Europe Market Observation, CCNR – Central Commission for the Navigation of the Rhine
[14] Port of Hamburg (https://www.hafen-hamburg.de/en/), Accessed in October 2021
[15] North-Sea Baltic TEN-T Core Network Corridor: Fourth Work Plan of European Coordinator Catherine Trautmann, 2020
[16] The role of short sea shipping and European rail corridors in intermodal freight transportation, Nobre, Universidade Nova de Lisboa, 2020
[17] Port of Duisburg (https://www.duisport.de/?lang=en), Accessed in October 2021
[18] Port of Antwerp (https://www.portofantwerp.com/en), Accessed in October 2021
[19] Port of Algeciras (https://www.apba.es/), Accessed in October 2021

Table 1: Total freight and containers handled in the four ports within ePIcenter in 2019

	Total goods handled (million tonnes)	Containers handled (million TEUs)
Port of Antwerp	238	11.9
Port of Hamburg	136	9.3
Port of Duisburg	110	4.1
Port of Algeciras	107	4.8
Total	**591**	**30.1**

Source: Authors‘ own compilation based on information provided by each port authority

Issues related to hinterland connectivity in TEN-T ports within ePIcenter

As Europe's largest railway port, the Port of Hamburg has the largest modal split of railway traffic on its hinterland (50.7%, in million tonnes). Despite this high share of rail traffic, road traffic still represents a considerable share (40.3%). Every week, the rail transport companies (EVU) offer almost 2000 container train connections, connecting the port to all economic inland regions and many European countries.

For the maritime port of Antwerp, accessibility by rail and road is considered as a major problem. Projects to accommodate this problem are either on-going or at least in planning. The share of rail traffic in 2020 was of only 8%, and road representing 58%. Nevertheless, the port has defined the goal to shift more to rail and inland waterways.

An important issue to improve port-hinterland connections is to focus on connections by rail or barge, thus avoiding excessive road haulage on motorways near seaports[20]. Here inland ports/hubs such as Duisburg can play an important role. One important factor influencing modal shift is to ensure contractual obligations on modal split of new port areas by different legal regulations: limitations for road transport and/or facilities for waterborne transport.

Every year, approximately 20,000 ships and 25,000 trains are processed, with 30% of rail traffic between Europe and China routed through the Port of Duisburg. Between 35 and 40 trains currently run between the German port and various destinations in China every week.

As a hub for the shipping lines that link Asia, America and Africa with Europe, the Port of Algeciras is one of only a few European ports that function as the starting point for two of the TEN-T´s main rail corridors. The rail link that connects Algeciras and Bobadilla/Madrid has thus been declared a double priority, which is expected to be completed and fully electrified by 2030.

Algeciras has a rail connection to Madrid. Nonetheless, the share of containers transported by rail remains very low (less than 2 percent). The 4th Work Plan of the Coordinator for the Atlantic Core Network Corridor[21] stresses that several limitations are still present in the interconnection between sea and rail transport. The Coordinator points out that despite all core ports in the Atlantic Corridor being connected to rail, it is still important to ensure high-quality connections, especially allowing 740 m trains to access the ports and ensuring the electrification of the entire lines, especially those connecting to the port of Algeciras, one of the largest in the Corridor in terms of volume. The port is also working on their Rolling Motorway project to develop a new intermodal service for Ro-Ro traffic crossing the Strait of Gibraltar and linking the EU with the North of Africa, reinforcing the rail connection to Madrid via the Algeciras-Bobadilla-Madrid line crosses through Andalusia and connecting all our logistics areas.

Some projects concerning last-mile connections to ports are also relevant for the functioning of the transport system in the Corridor. There are various projects in the Project Lists of the CNCs focusing on the improvements to land access and last-mile connections to ports, especially related to rail but also to road. Despite these high

[20] National Strategy for Sea and Inland Ports, German Federal Ministry of Transport and Digital Infrastructure (BMVI), 2016
[21] Atlantic TEN-T Core Network Corridor: Fourth Work Plan of the European Coordinator Carlo Secchi, 2020

investments, most ports still highly depend on road traffic, with the modal split of rail traffic in the hinterland remaining low, as shown in the following table.

Table 2: Modal split of hinterland traffic for the ports within ePIcenter in 2019

	Waterways	Road	Rail
Port of Antwerp	34%	58%	8%
Port of Hamburg	3%	50%	47%
Port of Duisburg	44%	37%	19%
Port of Algeciras	0%	94%	6%
Average	**20%**	**60%**	**20%**

Source: Authors' own compilation based on information provided by each port authority

2.3 A focus on digitalisation and standardisation

Among other aspects, ePIcenter aims at analysing the impact of the TEN-T and global networks on land connections and better addressing the potential of digital solutions. The Commission's Sustainable and Smart Mobility Strategy[22] succeeding the White Paper on transport points out that the digitalisation of port processes and data sharing among port stakeholders can help optimise logistics operations. Moreover, greater automation of container management and port operations, besides the adaption of port infrastructure to more automated modes of transport can contribute to ensuring more efficient port operations. This view was also shared by European TEN-T Coordinators, who argue that digitalisation is key for logistical competitiveness[23].

ICT/digital infrastructure for seamless and efficient port & hinterland operations

Digitalisation has the potential to increase the efficiency, safety, security and environmental performance both in the port as well as in the whole transport and logistics chain[24]. A more efficient supply chain brings significant gains for ports, who function as multimodal nodes, where maritime, road, barge and rail transport converge. Port managing bodies can thus support and help to facilitate the ongoing digitalisation process, as they are often a neutral matchmaker between all parties involved in port operations, the ship-port interaction and hinterland connectivity. They can help to create data hubs and provide interconnectivity and digital services to stakeholders in the transport and logistic chain. The COVID-19 crisis has given a boost to the digital transition in transport and logistics.

The Commission acknowledges that the digital transformation of maritime ports has been progressing, though smaller inland ports often lag behind. Therefore, the EC argues that it is important to ensure a more harmonised digitalisation of business operations, ensuring the digital integration of hinterland transport chains, which can be addressed through the (stronger) implementation of Single Windows and port community systems, besides using River Information Services (RIS) to their full potential.

In this regard, it is important to ensure full support to the emergence of open standards in maritime logistics, especially as the lack of industry standards for data sharing can hamper the establishments of common platforms for information sharing and collaborations. Nevertheless, it is important to clarify what should be standardised, whether publicly or industry-driven, and how the implementation of standards will be organised.

Reducing unpredictability in port operations can ensure a more efficient use of port infrastructure[25]. Although ports of the same region often compete, combined efforts to providing digital solutions for stakeholder

[22] Sustainable and Smart Mobility Strategy, {COM(2020) 789 final}, Brussels, 9.12.2020
[23] Joint Seminar organised by the European TEN-T Coordinators for Motorways of the Sea, the Mediterranean, and the Scandinavian-Mediterranean Corridors, 12th November 2019
[24] Position of the European Sea Ports Organisation in contribution to the Public Consultation accompanying the Impact Assessment for the revision of the TEN-T Regulation (EU)1315/2013 April 2021
[25] Information Sharing for Efficient Maritime Logistics, Case-Specific Policy Analysis, ITF, 2018

coordination could generate efficiencies from which all participating ports benefit. Therefore, it is crucial to intensify collaboration in implementing single entry points for administrative services, i.e. Single Windows. As pointed out in the case study focused on digitalisation under the scope of the evaluation of the TEN-T Regulation, Single Window Environments are important initiatives to shift operations from paper-based exchange of information to more electronic formats. In this vein, TEN-T policy can play a role in ensuring the creation of a level playing field and setting specifications and formats for the exchange of information.

Many efficiency bottlenecks in the maritime supply chain are related to co-ordination issues between different stakeholders. According to McKinsey[26], approximately 48% of container ships arrive more than 12 hours behind schedule, and congestion exacerbates costly waiting time in ports. The World Economic Forum[27] estimates that 1.29[28] trillion euros is at stake for logistics companies as a result of digital transformation of the sector worldwide until 2025. For maritime freight companies, they estimate potential savings of operating costs at 43 billion euros as a result of the adoption of analytics. Related inefficiencies, such as trade procedures, business and regulatory practices and constraints, or the insufficient availability and use of Information and Communication Technologies (ICT) contribute to these costs and sources of inefficiency. The problems for ports due to unpredictability and unreliability of vessel arrivals was also emphasised by the Port of Montreal during one of ePIcenter's workshops.

Information sharing presents a huge potential to the maritime logistics sector. It can reduce cost, cut delivery times and generally improve resource efficiency[29]. Information sharing across the logistics chain thus offers interesting business opportunities. Effective integration of data-driven systems crucially depends on the quality of their implementation and on smooth collaboration between stakeholders along the logistics chain.

ESPO argues that the proposed customs Single Window Environment could lead to further trade facilitation, reducing the administrative burden for businesses and increasing the efficiency of goods clearance, while also contributing to the ongoing digitalisation of the logistics chain[30]. Cross-border Single Window Exchange Platform Interconnection and the integration of national single windows into a bi-lateral or regional cross-border e-information exchange platform is an important instrument for regional integration and increased security, trust and collaboration between trading countries[31]. Therefore, Single Windows can enhance the availability and authenticity of information, reducing fraud, expediting and simplifying information flows between trade and Governments. This can result in a greater harmonisation and sharing of relevant data across Governmental systems, bringing meaningful gains to all parties involved in cross-border trade.

Maritime IoT applications have a particular potential for efficiency gains, considering the need to manage complex transport and supply chain systems, including both technical-operational and co-ordination efficiency. The importance of harnessing the Internet of (maritime) Things increases as commercial shipping appears to be on the verge of the adoption of autonomous ships and the implementation of e-navigation[32].

As previously pointed out, supply chains still heavily rely on paperwork. In this regard, the potential for the use of Distributed Ledger Technology (DLT), most notably blockchain, has been more closely explored by players in the transport industry. While blockchain is a type of DLT, other models emerge in that category as variations of the initial Bitcoin blockchain model. According to International Transport Forum (ITF), advantages of blockchain include its function as a distributed ledger that enables proof of ownership and the transfer of ownership between stakeholders without requiring a third-party intermediary usually needed to verify transactions. While companies already keep track of events and monetary assets associated to transactions, a number of inefficiencies usually occur in the system. Companies for instance keep a ledger of the owner, origin and destination of a shipment, which vessel or container has been used, and whether the transaction has been paid.

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[26] McKinsey (2017), "Container shipping: The next 50 years"
[27] WEF/Accenture (2016), "Digital Transformation of Industries: Logistics Industry", World Economic Forum White Paper, January 2016.
[28] USD:EUR exchange rate of 1:0.86
[29] A Changed World - the state of digital transformation in a post-covid maritime industry, Immarsat, October 2021
[30] Contribution of the European Sea Ports Organisation to the public consultation on the proposal for a Regulation establishing the EU Single Window Environment for Customs, 15 December 2020
[31] The Roadmap: Evolution of Single Window, UNESCAP, 2013
[32] OECD (2017a), The Ocean Economy in 2030, OECD Publishing, Paris

In shipping, Distributed Ledger Technology (DLT) pilot projects have been carried out by the Israeli carrier ZIM, consortia in South Korea and Japan, as well as Maersk and IBM. As pointed out in a 2018 ITF report[33], The International Port Community System Association (IPCSA) is currently running a blockchain pilot, aiming to establish a paperless Bill of Lading and to develop an open standard for the maritime industry with the Port Community Systems (PCS) operators.

In the European Union, authorities have been easing customs formalities through a harmonised electronic cargo declaration and the e-Manifest. Under the previous EU Reporting Formalities Directive (RFD) of 2010 (Directive 2010/65/EU), ships are supposed to deliver digital submissions to National Single Windows adapted to harmonised reporting formalities. For customs, the use of DLT can help access shipping, financial and consignment data remotely, for instance to reduce fraud or illicit trade, as well as systematic inefficiencies that otherwise drive-up transactional costs of cross-border trade. Moreover, the update of Directive 2010/65/EU[34] might reflect new changes in this regard.

While the Internet of Things (IoT) mainly connects devices and objects, the Internet of Everything (IoE) is a broader concept. IoE networks can include machine-to-machine (M2M), machine-to-person (M2P), or person-to-person (P2P) interactions. IoT can be seen as a subset of the IoE, as it represents a main technological feature of IoE. Other technological enablers of IoE are big data, cloud computing, P2P virtual collaboration, mobility and security.

According to the same 2018 ITF report, this model can be beneficial to a variety of areas in maritime logistics, such as operational and environmental efficiency, location and performance of assets, safety and security, maintenance, communication, customer services, among other aspects. For instance, the Hamburg Port Authority has sought to implement a holistic Internet of Everything model (smartPORT), considering not only the combined management of waterway, road and rails, but also staff and customer communication technology and the port environment. Many organisations in the sector still struggle to apply IoE concepts to their operations: IoE demands a high degree of transparency, up-front investments, staff training and organisational flexibility.

Data standards and interoperability in maritime operations

The lack of industry standards for data sharing can act as a hurdle to establishing common platforms for information sharing and collaboration. Public authorities should support the creation of open standards in maritime logistics to develop a configuration that is useful to all players in the supply chain. Therefore, it is important to clarify what should be standardised, whether standardisation should be publicly or industry-driven, and how the implementation of standards will be organised.

The evaluation of the TEN-T Regulation helped to identify some of the key challenges preventing further digitalisation and digital interoperability in the transport sector:

- Data challenges, which include limited data accessibility, for example concerning information such as infrastructure conditions, the position of vessels, cargo and traffic density.
- Many companies are not willing and/or allowed to provide certain data, for reasons of commercial sensitivity or data security.
- Integration, coherence and interoperability of systems – between different transport modes and along the supply chain. Beyond the IT systems, a key challenge is to ensure the interoperability of systems that were not always developed with integration in mind.
- Two-speed deployment, where distinct differences in the level of digitalisation appear, for example, between Northern Europe or Southern Europe, or between Western and Eastern Europe, or between continental Europe and islands.

[33] Information Sharing for Efficient Maritime Logistics, Case-Specific Policy Analysis, ITF, 2018

[34] Directive (EU) 2019/883 of the European Parliament and of the Council of 17 April 2019 on port reception facilities for the delivery of waste from ships, amending Directive 2010/65/EU and repealing Directive 2000/59/EC

The concept of interoperability was seen by a number of stakeholders consulted in the evaluation as paramount in the definition of digitalisation. This includes ensuring that systems are interoperable between modes of transport and different types of stakeholders (B2B, B2A). Some stakeholders also expressed the view that the interoperable interfaces should avoid standards which would incur large costs.

In their view, the digital infrastructure should be seen as part of the physical infrastructure rather than as an add-on. In order for the TEN-T network to take full advantage of the efficiency gains from digitalisation, a minimum level of digital infrastructure needs to be put in place.

Digital infrastructure, among many other definitions, can encompass the physical assets required for the technologies to operate. In its widest definition, this includes unmovable sensors (on the road, rail and waterways infrastructure), sensors on vehicles, Wi-Fi or 5G technologies to ensure the network is covered.

However, in order to fully exploit the potential of the digital transition in ports, proper digital infrastructure and data transmission capabilities have to become available such as high-capacity broadband, Wi-Fi and 5G. It is crucial that all ports become part of this the digital transition. Nonetheless, the growing dependence on digital solutions and data-driven operations must go hand in hand with a cybersecurity and cyber-resilience framework. Thus, it is important that the EU embraces a policy which protects business continuity while also ensuring the mitigation of possible cyber-attacks, without hampering the progress of digital innovation. According to ESPO, the TEN-T (funded through the Connecting Europe Facility), should be used to improve the resilience of Europe's port infrastructure to cybersecurity threats.

A cyber-safe and efficient digital infrastructure, mainly through Port Community Systems (PCS), enables smooth data exchange. A PCS enables intelligent and secure exchange of information between public and private stakeholders through enabling a single submission of data which becomes available for (selected) third-parties to optimise, manage and automate port and logistics processes (e.g. documentation for exports, imports, hazardous cargo, ship manifest information, port health formalities and maritime statistics reporting). Thus, digital infrastructure is aimed at eliminating unnecessary paperwork which can cause delays in cargo handling, at improved security, at cost reduction and at more environmental sustainability.

2.4 TEN-T & the Silk and Arctic Routes

Impact of China's BRI (Silk Route) on maritime trade of ePIcenter ports

China's Belt and Road Initiative (BRI) will likely have a significant impact on maritime trade flows if and when fully implemented. The maritime part of the initiative has a stronger potential to impact overall trade than the terrestrial investments, focussed on railway links and pipelines. Investment in the ports connecting China with other parts of the world could reduce maritime trade costs, thus reducing trade costs and increasing imports and exports[35].

A transport network consisting of a "Belt", i.e. overland transport connecting China to Europe through Central Asia, and a "Road", i.e. a maritime return-route from southern Europe, through Suez, back to Asia, with a stopover at East Africa (alternatively known as the "Maritime Silk Road"). Therefore, the Mediterranean Basin therefore 'central' in this network, connecting Asia with Europe, Africa and the Americas.

Studies show that a 10% increase in connectivity between countries along the "Maritime Silk Road" can deliver a 3% decrease in Chinese trade costs which would in turn boost China's imports and exports by around 6% and 9% respectively[36]. The latest studies by the World Bank and other international institutions suggest that BRI cooperation could reduce the costs of global trade by 1.1 to 2.2 percent.

[35] Commercial Navigation Along the Northern Sea Route: Prospects and Impacts Commercial Navigation, ITF, 2020

[36] China's Belt & Road Initiative: Connecting maritime transport flows for trade-driven prosperity, multilateralism and global peace, 15-16 April 2019

Nonetheless, predicting the effect of the BRI on the transport network is particularly challenging as there is no clear definition or programme for the BRI. What's more, it is somewhat complex to distinguish trade specifically generated by the BRI from the trade between the Far East and Europe. For maritime freight, it is estimated that the total westbound and eastbound trade flows between Far East and the EU were just over 16 million TEUs in 2016[37]. Based on the forecasts presented in this study for the TRAN Committee in 2018, the total two-way freight traffic can reach approximately 40 million TEUs by 2040 – a 250% increase, either directly or indirectly motivated by the BRI. The same study also highlights that as a result of improved connectivity as a result of the BRI, roughly 2.5 million TEUs could be transferred to maritime transport.
The analysis of the routes most likely to be used in the future for the shift of container traffic to rail and maritime transport shows that the most likely route is through the north of the Alps, towards EU Member States bordering the North Sea and the Baltic Sea. This route is expected to primarily carry by rail containers which previously had been shipped to North Sea ports. These containers are expected to mostly travel along the corridor from Moscow (Russia) through Brest (Belarus) and Warsaw (Poland) to Berlin (Germany), including part of the TEN-T North Sea – Baltic Core Network Corridor.

The BRI is not expected to alter the overall trend of shipping traffic, though it may have a marginal negative effect on the volume of freight entering the EU via the North Sea ports. Nonetheless, potentially greater uncertainty in the future growth of rail traffic on the North Sea - Baltic Core Network Corridor between Athens and the landlocked States bordering the Danube can be expected. The table below shows the effect that the BRI can have on ports, especially by developing new routes. The analysis shows that the effects vary, and maritime trade can be negatively affected in ports connected by rail.

Table 3: Possible trade effects of the Belt and Road Initiative on ports

Objective	Port category	Effect on maritime trade
Control of existing routes	Hub ports near maritime routes/chokepoints	None
Alternative routes	Hub ports to support new routes	Different configurations of flows
New trade	Gateway ports near untapped export markets or strategic commodities	More maritime trade
Modal shift	Ports connected by rail	Less maritime trade

Source: Commercial Navigation Along the Northern Sea Route: Prospects and Impacts Commercial Navigation, ITF, 2020

Within ePIcenter, the Port of Duisburg is connected to the New Silk Route, offering connections from the port to China. According to the Duisport, the connection between the Port of Duisburg to China by rail is faster than by ship, and considerably cheaper than air transport. Unlike any other region in Europe, Duisburg is connected to the major commercial centres in Asia by rail. Approximately 60 freight trains arrive in the port every week, which are then either further transported to domestic seaports or to neighbouring European countries.

As a complement to air and sea freight, rail connections offer travel times from Duisburg to the main hubs in China between 12–16 days, faster than by ship and at the same time significantly cheaper than transporting freight by air. Travel time from Duisburg to the main hubs in China is between 12-18 days.

[37] Research for TRAN Committee: The new Silk Route - opportunities and challenges for EU transport, 2018

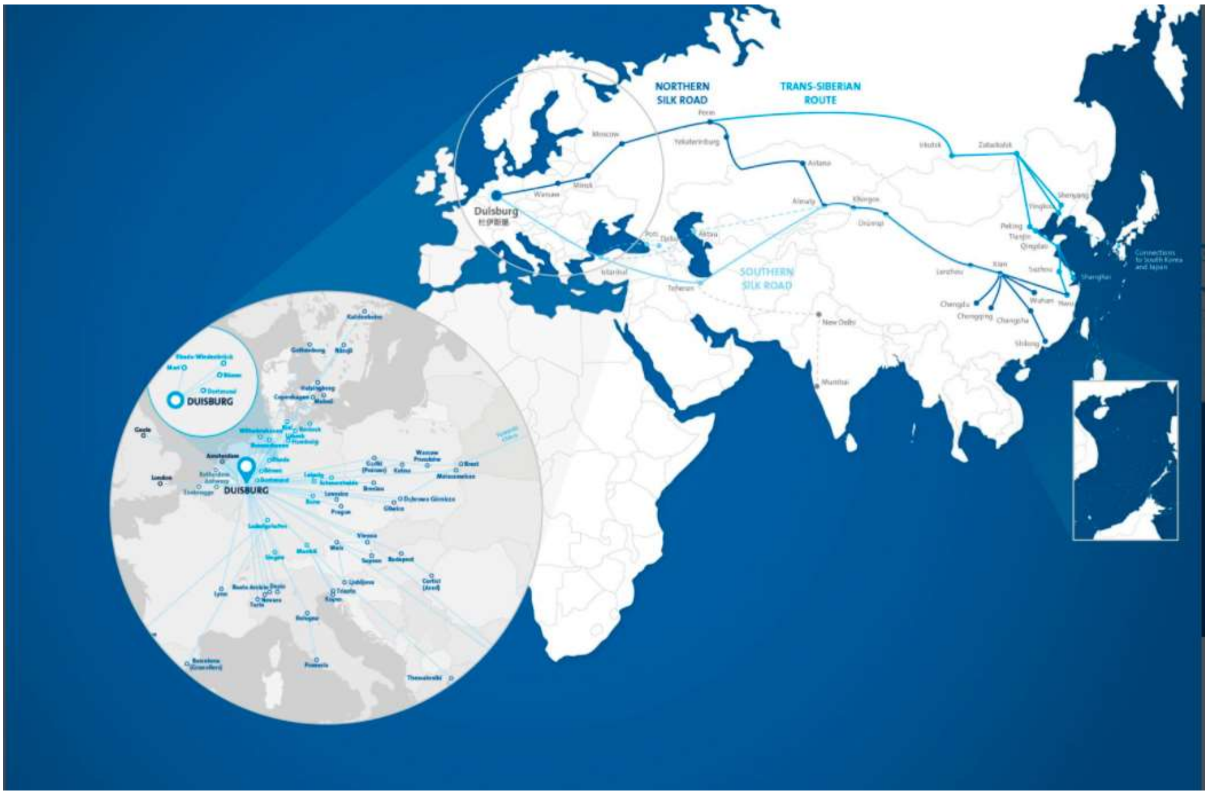

Figure 1: Silk Route to China from the Port of Duisburg
Source: Port of Duisburg

Recommendations from the study carried out for the TRAN Committee on the BRI highlight the following aspects of interest. Firstly, the EU should engage in dialogue and cooperation with China, seeking greater clarity on the BRI's future plans, and encourage the development of studies concerning the connection of specific TEN-T and BRI corridors in the framework of the "Connectivity Platform" (starting from the North Sea –Baltic Core Network Corridor and the New Eurasian Land Bridge Corridor of the BRI, thus promoting further maritime and rail trade traffic). Secondly, the study pints out that the TEN-T network does not need to be modified due to the BRI. Nevertheless, authors propose reviewing the TEN-T Corridor Studies, in combination with the work of the "Connectivity Platform" and the progress of BRI, especially in the Corridors most affected by such developments (namely the NSB).

Better coordination of TEN-T and BRI policies will only be possible with greater clarity on the definition of the BRI[38]. There are no definitive maps of the various BRI corridors analogous to those published by the European Commission showing the various TEN-T Core Network Corridors, and no Corridor Studies for the BRI providing detailed information on route characteristics, capacity and investment priorities. Such maps and studies could be prepared for a limited number of priority Corridors connecting with TEN-T routes and the wider European transport network.

There is uncertainty on the availability of future capacity at and between airports, ports and rail terminals across Eurasia and other areas covered by the BRI, thus such studies can help prevent any possible bottlenecks. Investments attributed to the BRI are only a small part of the overall investment which will in any case be made by the owners and managers of air, sea, rail and road infrastructure across Eurasia.

The analysis of BRI-related traffic flows suggested that the BRI could generate additional rail freight of approximately 3 million TEU (equivalent to 50-60 trains per day or 2-3 trains per hour each way) between the

[38] The "Belt and Road Initiative": impacts on TEN-T and on the European transport system, Dunmore et. al (2019)

Far East and the EU by 2040[39]. The most likely TEN-T Corridor to be required to accommodate this traffic would be the North Sea-Baltic Core Network Corridor.

The BRI is not expected to generate great changes in the patterns of shipping traffic, other than to slightly reduce the volume of freight entering the EU via the North Sea Ports. Any effect might be offset by a growth in the shipment of BRI-generated freight across the North Sea to the UK and Ireland. Nevertheless, it should be noted that maritime trade between China and the EU is already well-established, and that it is not possible to forecast possible changes in related trade patterns as a result of the BRI.

Impact of Arctic Routes on maritime trade of ePIcenter ports

There are three main routes along the Arctic: the Northern Sea Route (NSR), the North-West Passage (NWP) and the Transpolar Sea Route (TSR). The NSR is the most promising route, as it is the link between Europe and Asia, besides due to its less harsh climate (with less icy conditions). In 2019, the NSR was opened to transit for 30% of the year, from July to November[40]. The Artic Route has great potential as a transoceanic route, though clearer results will only become clearer in the long-term rather than in the near future.

The Artic route is expected to be complementary to existing Suez and Maritime routes. The Arctic is currently used as a maritime energy corridor rather than as a global route.

Modelling projections suggest that the share of global trade using the Northern Sea Route by the next century will be less than 5%, even in extreme climate change scenarios. Nevertheless, various stakeholders remain interested in developing relevant infrastructure in the Arctic Seas despite uncertainties. If a Central Arctic passage became feasible, it could generate a considerable shift in the configuration of maritime trade flows, having important impacts in the transport and energy sectors. The figure below shows the routes being developed along the Artic, highlighting the presence of the ports of Hamburg and Antwerp along these.

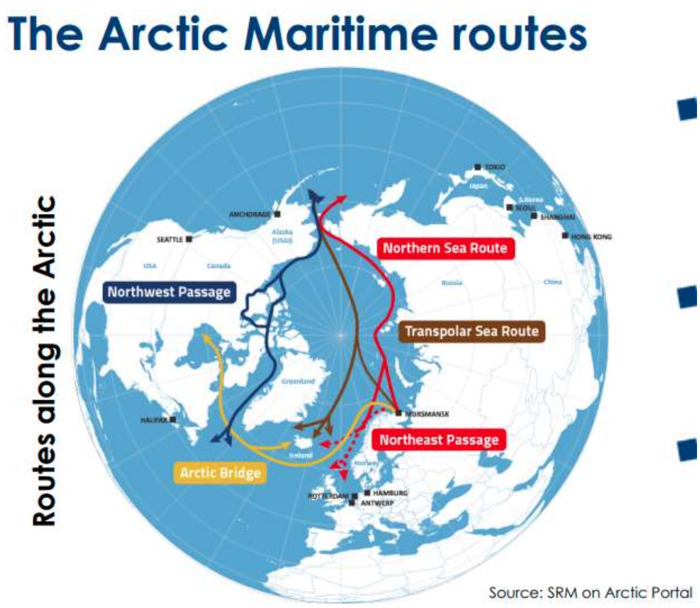

Figure 2: The Arctic Maritime Routes

Source: Presentation from INTENSA SAOPAOLO for the Circle S.p.A. in 2020

[39] Research for TRAN Committee: The new Silk Route - opportunities and challenges for EU transport, 2018

[40] The Arctic Maritime Routes, INTESA SANPAOLO, 2020

Even in scenarios of rapid temperature rises, there will be considerable periods of the year that the Northern Sea Route will not be navigable because it will not be ice-free. The parts of the Northern Sea Route that are most attractive for shipping are also the shallowest. Therefore, under the most extreme climate scenario, the transit of ships of less than 50,000 tonnes via the Northern Sea Route can only become profitable after 2035[41]. However, for several decades these volumes will change only marginally compared to using the southern sea routes via the Suez Canal. In the extreme climate change scenario, substantial bulk volumes will only boom by 2070, and it can take even more than a century in more moderate climate change scenarios. Even in the most extreme climate change scenario, the share of global trade using the Northern Sea Route by 2200 will still be less than 5%[42]. Therefore, considerable impacts are only foreseen too far away in the future.

As previously mentioned, in spite of the constraints, considerable investments related to Arctic shipping are taking place. These are investments in icebreakers, industrial projects, ports and related infrastructure. According to ITF, there are now 55 operational icebreakers, 13 are under construction and another 13 being planned. Russia is constructing three new nuclear icebreakers that will be delivered in the short-term. Various industrial groups, often through State funds, have developed industrial projects related to gas, oil, coal and nickel, which need new ports to serve these investments with ancillary development of maritime observatories and stations for service drones.

Both China and Russia have great expectations regarding the potential of NSR as an alternative to Suez. Such investments can also be beneficial to ports across Europe, especially for Antwerp and Hamburg (both within ePIcenter). For instance, the table below show how the Northern Sea Route along the Arctic can help reducing journey times from Hamburg to China by sea.

Table 4: Time savings when transporting on the Northern Sea Route

Route	Trip from Hamburg to Yokohoma		
	Distance (Nm.)	Speed (knots)	Travel time (days)
Suez Canal	11.585	15	32
Norhter Sea Route	7.356	14	18

Note: Speed may depend on weather conditions.

Source: Rhman, Saharuddin and Rasdi (2014)

As a result of the Silk Route, scheduled connections between the Port of Duisburg and terminals in China have resulted in an extremely reliable option for the exchange of goods and more. In this regard, the Arctic Route has great potential as a transoceanic route, but this will probably become more apparent in the long-term rather than in the near future. Suez and the Mediterranean will remain central for a long time. The development of the Artic route will be complementary, especially as the Arctic is currently a maritime energy corridor rather than a global cargo route[43].

2.5 The TEN-T and third countries

The existing provisions on neighbouring countries allow the European Union to support, especially financially, projects of common interest and adopt TEN-T maps extending towards third countries. The technical identification and political validation of such extended networks is not only the basis for regional integration at the EU borders, but also provides the EU's partners with an essential tool for planning[44].

[41] Yumashev, D., van Hussen, K., Gille, J. et al. Towards a balanced view of Arctic shipping: estimating economic impacts of emissions from increased traffic on the Northern Sea Route. Climatic Change 143, 143–155 (2017)

[42] Commercial Navigation Along the Northern Sea Route: Prospects and Impacts Commercial Navigation, 2018

[43] Arctic Route: challenges and opportunities - The Arctic Route: a new scenario for global maritime trade, SRM, 2020

[44] The External Dimension of the EU's Transport Infrastructure Policy, Stefano Paci (2021)

The Union has already adopted indicative TEN-T maps for the European Economic Area (Norway, Iceland and Liechtenstein), Switzerland, the Western Balkans, the Eastern Partnership and Turkey (comprehensive network). Negotiations are ongoing with the South Mediterranean Countries.

The Commission's Work Programme for 2021 includes plans to review the TEN-T legislative provisions. This plan aims at improving links with neighbouring third countries. For transport infrastructure, the focus is on the neighbouring regions, where enhancing sustainable connectivity is a strategic objective of the EU. The EU's Economic and Investment Plan in the Western Balkans, for instance, has the goal of paving the way for a long-term economic recovery of the region and foster regional economic integration, including through a green and digital transition. This support is aimed at being largely directed towards sustainable transport connectivity (with three flagship transport infrastructure initiatives), considered a strategic area for economic development. The extended TEN-T network acts as the reference point for infrastructure investments in the region.

According to the European Commission, over €1 billion was allocated in grants to infrastructure development through the Western Balkan Investment Framework (WBIF) in the period 2014-20. Appropriate reforms in the transport sector to ensure seamless transport will be essential to reconnect the Western Balkans and the EU. Nevertheless, administrative bottlenecks, uncoordinated practices and a lack of data interchange still need to be tackled.

Through the EU-China Connectivity Platform (established in 2015), regular exchanges on transport infrastructure policy and development plans are taking place with a view to identifying and defining possible synergies between the EU's TEN-T and China's Belt and Road Initiative (BRI). Both sides are preparing to launch a Joint Study on Sustainable Railway-based Transport Corridors between Europe and China, as agreed in the 2019 Summit of EU-China leaders. Following the COVID-19 pandemic, both countries are also allowing on the mutual recognition of COVID certificates, promoting free and safe movement within the EU and beyond. Furthermore, the EU also works closely with the International Maritime Organisation (IMO), the International Civil Aviation Organisation (ICAO), ensuring close trade with non-EU countries and which can be replicated to other regions and sectors.

The strong cooperation developed between the EU and China, and the on-going advances on the BRI can offer a chance for small developing European countries, such as Montenegro in the framework of TEN-T and opportunities for its repositioning within Comprehensive Network plans. This development can be important as a way to promote further cooperation and trade with the Western Balkans through Montenegro, enabling greater integration and maritime trade through European ports (especially in the form of short-sea shipping).

2.6 Other relevant Horizon Europe Initiatives relevant for ePIcenter

As pointed out in the introduction, ePIcenter is closely linked with the development of Connection Europe Facility projects ELETA30 (benefits of exchangin ETA through rail supply chain management) and FEDeRATED (interoperable infrastructure for the exchange of business and administrative data for freight transport and logistics), both under the DTLF umbrella.

Stakeholders consulted within the evaluation of the TEN-T Regulation argued that the Regulation has remained flexible and relevant enough to contribute to the digitalisation of the transport sector. This has been boosted by other initiatives from the European Commission. Projects such as FEDeRATED, building on the work of the Digital Transport and Logistics Forum (DTLF), aims at contributing to "a viable federated network of platforms for data sharing in the freight transport and logistics domain at EU level (and beyond). The main objective is to enable a smooth and effective public involvement with logistic chains for the execution of public duties." In a similar fashion, the objective of the FENIX project, launched in September 2019, is to create a viable and valid federative network of platforms as enabler for Business to Administration (B2A) and Business to Business (B2B) data exchange and sharing by transport and logistics operators.

Between 2010-2013, British Maritime Logistics and partners carried out European-funded project e-freight[45]. project denoted the vision of paperless freight transport processes where an electronic flow of information is linked to the physical flow of goods. Related developments are expected to lead in the future to "Intelligent Cargo", meaning that goods will become self-context and location-aware as well as connected to a wide range of information services, thus automating further the transportation management process. Moreover, the project contributed towards the development of the Single Window concept. The findings from the e-freight projects were reflected on the update of ISO 6683-1:2013 on Intelligent transport systems — Freight land conveyance content identification and communication, which was updated in 2018.

Besides these, other important projects under Horizon Europe can be aligned with the developments of ePIcenter.

For instance, GREEN C Ports Action[46] aims at analysing digitalisation tools and technologies to support port environmental sustainability and performance of port operations in the TEN-T Core Network. The project will pilot the use of sensors, big data platforms, business intelligence tools and artificial intelligence modelling at the ports of Valencia, Venice, Piraeus, Wilhelmshaven and Bremerhaven, contributing to the future roll out of these technologies in the market.

The first phase of the project will comprise the design, acquisition, engineering adaptation and installation of the different sensor networks at the participant ports. These sensor networks will gather environmental data of different types (e.g. air quality parameters, meteorological information, noise, congestion at gates, among other), transmitting it to a Port Environmental Performance (PEP) IT platform that will be programmed to receive real time data from the sensor networks and from existing operating systems in the port (i.e. PCS, PMIS and TOS).

The second phase of the project will commence once the installation of the necessary equipment to build the required environmental sensor network is completed. At this stage, partners of the GREEN C Ports project will develop methods and analytics following big data techniques and advanced modelling, which will allow predictive analyses of ports' environmental performance. By analysing the data gathered from the sensor networks together with existing information supplied by different port authorities and community systems, it will be possible to build models and advanced algorithms to predict in real time the impact of the environmental conditions over port operations (ship loading/unloading, port congestion, traffic management, etc.) and also over nearby city areas in terms of air quality, noise and other relevant parameters.ernal EU countries to submit national implementation plans and reporting of KPIs compliance.

Another project of interest is PLANET[47], which, among other aspects, aims at analysing the main European trade routes and transportation trends, both at a macroscopic and microscopic level, by taking into consideration: trade -flows and - policies, emerging trade routes, infrastructure capabilities, connectivity performance of principle entry nodes and other parameters. Within the Position Papers developed under PLANET's frame, the project shall focus on understanding the impact of current and emerging routes on the TEN-T, land interconnection issues of the TEN-T with networks outside EU, with particular interest in rail transport. Moreover, it also aims at understanding the benefits of the potential adoption of Physical Internet (PI) concept and enabling technologies for more efficient and environmentally friendly operations in the transport and logistics sector.

The project's Newsletter #3 from October 2021 points out that trade flows and patterns to/from and within Europe are expected to change significantly over the next years, with the creation of new trade routes connecting Europe to Asia, especially connecting Europe to China. The most important underlying geo-economic reasons for this phenomenon are: i) the trend for change in the current model of globalised production towards the regionalization of production, especially for middle-high end/strategic products; ii) the 'One Belt One Road' initiative, which consists of six economic corridors and includes both a maritime and a land connection to Europe;

[45] E-freight project (https://trimis.ec.europa.eu/project/european-e-freight-capabilities-co-modal-transport), Accessed in October 2021
[46] Green C Ports Project (https://greencportsproject.eu/overview/), Accessed in October 2021
[47] PLANET Project (https://www.planetproject.eu/), Accessed in October 2021

iii) environmental parameters related to the climate change (melting of Arctic ice, longer periods of drought); iv) Russia's ambitions to exploit the Arctic region, including a maritime route; v) Russia and India's intention to connect through the development of the international North-South corridor through Central Asia, which also bypasses the Suez Canal. Some of these conclusions have already been reflected above.

In order to track and monitor the dynamics and potential impact of emerging routes to TEN-T existing corridors, PLANET suggests using the Corridor Connectivity Index (CCI). Its goal is to measure and monitor connectivity of principal entry nodes/inland nodes, which can be applied as a barometer of changing trade flows. A higher CCI is indicative of a more attractive to transport goods via this principal entry node/inland node and, whereby, monitoring and comparing CCI values over time can be linked to new-trade routes. The use of this CCI can be relevant for the activities developed under ePIcenter, which may be expanded to include other issues of interest. The figure below shows a schematic illustration of the CCI used within PLANET.

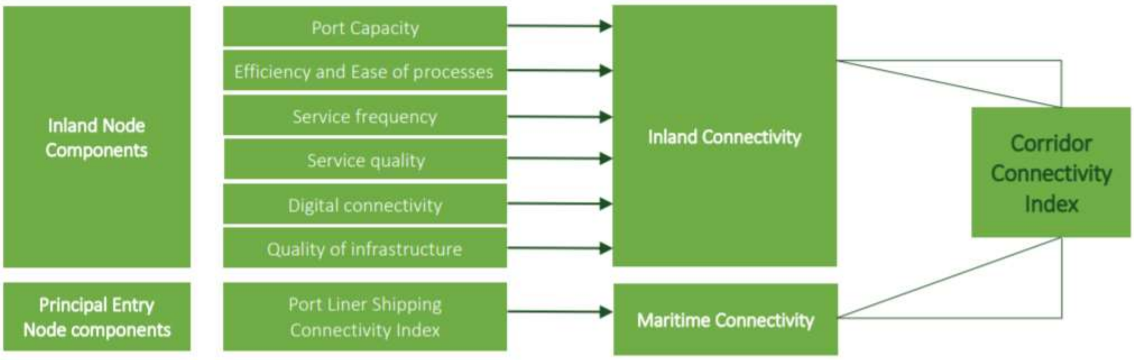

Figure 3: Main dimensions of the CCI indicator used within the PLANET project

Source: HE's PLANET Project Newsletter #3, October 2021

3 Lessons Learned

3.1 A focus on ePIcenter's use cases and impacts on the TEN-T

ePIcenter's use cases focus on autonomous vehicles (T-pods); and Artic Route planning and AI-based propulsion algorithms; and modular containers (Connectainer). These use cases shall reflect on different aspects which can directly or indirectly impact on port operations, as well as on the flow and performance of the TEN-T network. In addition, these activities can also be felt on the links between the TEN-T ports and their hinterland connections with new global routes.

In order to track and monitor the dynamics and potential impact of emerging routes to TEN-T existing corridors, certain Key Performance Indicators (KPIs) may need to be considered. In general, the most relevant criteria to assess the quality of port hinterland connections should consider the cost and quality of hinterland connections, the existence of intermodal links (referring to the port accessibility by land and sea, number and frequency of road and rail links, hinterland size, intermodal platforms, inland freight rates). Moreover, indicators referring to the digitalisation of port operations, namely through the implementation of Maritime Single Windows and other electronic freight aspects can be incorporated.

The consolidation of ports as logistic and intermodal hubs is an essential step to take. Port capacity is translated into economies of scale that enable cost reductions. Besides, maritime and land connectivity represent key elements of competitiveness. Thus, it is precisely the land connections - particularly rail connections - that remain the Achilles heel of South-European ports.

These factors are also considered in the Corridor Connectivity Index (CCI) referred in PLANET's project. Its goal is to measure and monitor connectivity of principal entry nodes/inland nodes, which can be applied as a barometer of changing trade flows. A higher CCI is indicative of a more attractive to transport goods via this principal entry node/inland node. Therefore, monitoring and comparing CCI values over time can be linked to new-trade routes. The use of this CCI can be relevant for the activities developed under ePIcenter, which can be broadened to include other issues of interest, namely regarding the efficiency and digitalisation of port hinterland connectivity, considering how these include greener and innovative transport modes (e.g. the future deployment of the Hyperloop and autonomous vehicles for last-mile connections and their impact on overall efficiency).

3.2 General Remarks

ePIcenter focuses on analysing the impacts of global supply chains, taking into account emerging transport modes and important global trade routes, such as the Silk and Arctic Routes, aiming to achieving a more efficient and sustainable multimodal freight transport system and logistics. In this context, project has the general goal of making better use of digital solutions on transport connections, especially port hinterland connections. The project's activities thus aim at ensuring a seamless integration of the digital infrastructure layer through secure international information flows and digitalisation.

It is important to bear in mind that the digital layer of transport infrastructure is not disconnected from the physical layer. The digitalisation of existing infrastructure can make the transport supply chain more efficient. Nevertheless, although the TEN-T Regulation focuses on digitalisation, a greater importance should be placed on the digital infrastructure layer.

Maritime and inland ports are important nodes for the TEN-T, especially as every Core Network Corridor (CNC) starts or ends in a port. Ports fulfil an important role in trade development and as gateways of a multimodal network. They are of major relevance as digital hubs, having taken significant strides for a strong digital transport infrastructure. For many seaports, the weakest link is still its hinterland connections, especially due to the lack of adequate levels of rail, road or inland connections and due to congestion on these routes.

Among other aspects, the European Commission stresses that the optimisation of port services and operations can result in a number of TEN-T ports being able to handle or attract more cargo and passengers and obtain significantly higher performance with the existing infrastructure, thereby reducing the need for funding. A functioning hinterland transport network is an important determinant of economic growth. In this regard, the TEN-T aims at strengthening Europe's international competitiveness by improving the accessibility of certain regions. More specifically, the TEN-T core network aims at bridging the gaps between different national transport systems. Improved infrastructure is expected to have a significant impact on the ports' hinterland connectivity and transport efficiency. Therefore, the consolidation of ports as logistic and intermodal hubs is an essential step to take.

Stakeholders logistics chain have carried out important investments in ICT infrastructure. For instance, the application of the EU Vessel Traffic Monitoring and Information System (VTMIS) can be one essential step to making maritime transport smarter. Moreover, the EU Regulation on electronic freight transport information (eFTI) has already enabled more efficient multimodal logistic chain operations, ensuring the harmonisation and establishment of an EU framework for existing freight information, while also encouraging the use of electronic documents.

Information sharing offers a great potential to the maritime logistics sector, reducing costs, delivery times and present overall improvements in the overall port logistics chain. The development of the European Maritime Single Window (EMSW) has been key in this regard.

The ports inserted within ePIcenter cross six TEN-T Core Network Corridors, having considerable impact on the entire network. The four ports inserted within ePIcenter combined handled over 591 million tonnes of freight and over 30 million TEUs of container traffic in 2019.

Despite the various investments on last-mile connectivity to ports, the modal split of rail traffic on the hinterland of ports in ePIcenter is still low. The Port of Hamburg presents the highest share of hinterland port connectivity (47%), while the Port of Algeciras had a modal split of rail connectivity of 6%. The average share of rail transport in the hinterland of all four ports in ePIcenter is of 20%. However, as the Spanish case demonstrates, rail transport is not a necessary condition to grow hinterlands.

The Spanish case may be generalised to cases of ports serving hinterlands at short/medium distance, in which investments in inland terminals tend to be speculative and based on public support. While there has been significant investment in inland terminals for reasons of port competition, many developments are also intended to boost economic development as well as reduce emissions through modal shift, thus many terminals are developed by consortia involving both port and inland actors.

The connection between TEN-T ports and new global routes such as the Silk Route (through the Belt and Road Initiative – the BRI) and the Arctic Route can generate important shifts in the patterns of shipping traffic, especially in ports in the North Sea region. The BRI is not foreseen to modify the general trend of shipping traffic. Nevertheless, it may have a marginal negative effect on the volume of freight entering the EU via the North Sea ports, especially on the North Sea - Baltic TEN-T Core Network Corridor. Within ePIcenter, the Port of Duisburg is connected to the New Silk Route, offering connections from the port to China. According to the Duisport, the connection between the Port of Duisburg to China by rail is faster than by ship

As a result of the Silk Route, scheduled connections between the Port of Duisburg and terminals in China have resulted in an extremely reliable option for the exchange of goods and more. In this regard, the Arctic Route may also have the potential as a transoceanic maritime route, although the long-term rather than in the near future. The development of the Artic route will be complementary, especially as the Arctic is currently a maritime energy corridor rather than a global cargo route.

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