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FROM HURDLES TO HIGHWAYS: STRENGTHENING INTERMODAL TRANSPORT FOR EUROPE'S GREEN FUTURE

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Abstract
Intermodal transportation has become a crucial solution to increase effectiveness, sustainability and resilience of transportation system in the European Union. This article explores the main challenges and opportunities of intermodal transportation networks emphasizing on the interconnectedness, eco-friendliness and integration important for smooth operations. As the EU aims to decrease its carbon footprint and improve transportation efficiency, intermodal systems- combining rail, road, waterway and air transport, are becoming extremely important. However, even after all the benefits, the development of intermodal transport faces a number of barriers such as limited infrastructure, complicated regulations and technological difficulties. This article offers a thorough analysis of these obstacles and proposes strategic suggestions for improving intermodal transport network. It demonstrates how the technological innovations, regulatory harmonization and infrastructural investment can address these challenges by thorough evaluation of existing literature and case studies. The paper also presents opportunities to improve environmental sustainability, lessen traffic and boost economic growth across the EU. With a specific focus on policy frameworks, industry cooperation and emerging trends, this study aims to add to the current discussion on sustainable transport and the role of intermodal systems in accomplishing EU climate targets.
Keywords: Intermodal Transportation, Logistics and supply chain management, Sustainable transport, Transport Infrastructure Development.
JEL classification: R40, R42, Q56

Introduction

Modern logistics networks can be made more efficient, sustainable and connected by the adoption of intermodal transport. The combining of multiple modes of transport like rail, road, waterway and maritime shipping- within a single supply chain framework is central to achieving European Union's green transition goals and boosting economic competitiveness. Intermodal freight system presents a viable option to reduce emissions, alleviating road traffic and encourage modal change to rail and inland waterways, as the EU continues to address the environmental impacts of transport (Chowdhury & Srai, 2021; Islam & Dinwoodie 2019). Despite its potential, the implementation of intermodal transport systems across the EU remains fragmented and uneven. Particularly in cross-border infrastructure disparities, policy misalignments and institutional barriers continue to exist (Woxenius, 2021; Mankowska et al. 2021). Although a modal shift from road to rail and waterways has been encouraged by EU policy tools, it has been difficult to achieve operational consistency among member states (Islam & Dinwoodie 2019).

Frameworks for sustainable supply chain management emphasize on how it is important to incorporate social, economic, and environmental factors into logistics choices (Bask et al. 2018). Intermodal transport closely complies with these principles by promoting resource efficient and low-carbon logistical operations. By reducing environmental effects of last mile of delivery, city logistics strategies can further enhance intermodal transport in urban environments (Russo & Comi 2020).

Many academics have made extensive contributions to the body of knowledge pertaining intermodal transport. To lessen supply chain bottlenecks, Rodrigue (2020) emphasized the role of multimodal hubs and global logistics corridors. Macharis and Melo (2011) concentrated on decision making tools for intermodal infrastructure planning. While Tsamboulas and Kapros (2003) helped evaluate regulatory policies supporting modal shift, Notteboom and Winkelmans (2001) examined the governance of intermodal terminals. Liu et al. (2019) presented data-driven frameworks for evaluating intermodal performance, however Crainic and Kim (2007) addressed routing and synchronization isuues in multimodal networks. In the meantime, Caris et al. (2012) and Evangelista et al., (2014) provided perspective on the adoption of innovation and ICT integration in multimodal logistics systems. Despite major contributions, gaps remain about how technological innovations, infrastructure fragmentation, legislative harmonization affect intermodal development across EU regions.

This research problem is of increasing interest due to increased environmental concerns, the European Green deal's carbon reduction goals and geopolitical shift impacting European transport corridors.

The scientific problem addressed in this paper is: How to optimize intermodal transportation in the EU to ensure sustainable, efficient, and resilient logistics operations, especially in the context of technological innovation and regulatory complexity?

The hypothesis of this study is that the performance of intermodal transportation maybe significantly enhanced by the synergistic integration of digital technology, harmonized policies and infrastructure modernization.

The purpose of this study is to investigate the potential challenges and opportunities in EU intermodal transport sector by analyzing infrastructure, regulatory policies, technological advancements and sustainability efforts.

To accomplish this, the study pursues following objectives: the current state and structure of intermodal transport in the EU by identifying the operational, institutional, and technical barriers to effective multimodal integration; the role of the Internet of Things (IoT) in improving intermodal coordination and streamlining logistics operations; the influence of environmental regulations and EU policies on promoting sustainable freight transport across Europe; and provided strategic recommendations for enhancing EU-wide multimodal logistics systems, ensuring better efficiency, sustainability, and integration

The focus of the research -the intermodal transportation system in the EU.

The subject of the analysis is the factors effecting the efficiency and sustainability of intermodal logistics, including policy, technology and infrastructure.

Literature review

Over the past decade, intermodal transport has significantly expanded throughout the EU. Rokicki et al. (2021) examined this growth across EU nations between 2008 and 2019, intermodal transport significantly rose particularly when analyses in ton-kilometers. The study also highlighted a drop in concentration, which suggests that member states are adopting it more extensively.

Šakalys and Palšaitis (2006) focused on the new EU member states, highlighted key measure for intermodal transport development such as adoption of innovative technologies, infrastructure modernization and establishment of logistics centers. They also provided recommendations on how to encourage intermodality to both European Commission and national governments. EU policies that promote sustainable mobility, improve cross border logistics, and achieve mode balance have significantly influenced the growth of intermodal transportation in the EU. Since the early 2000s, EU has highlighted the need to shift freight from road to rail and inland waterways which are more sustainable with frameworks like the European Green Deal (2019) and the White Paper on Transport (2011) (European Commission, 2011; European Commission, 2019).

Intermodal Freight transport in EU nations increased steadily from 2008 to 2019, with countries like Germany, the Netherlands, Belgium setting the standard for both modal integration and infrastructure (Rokicki, Perkowska & Perkowski 2021). Their longitudinal analysis highlighted general increase in intermodal ton- kilometers and a gradual decentralization of market concentration, showing wider adoption across member states.

The role of digitalization and harmonized logistics was emphasized in promoting the growth of intermodal freight transport (Liedtke & Wittenbrink 2020). Their research found that the interoperability between modes of transport has increased as the outcome of EU-backed pilot initiatives like Shift2Rail and Digital Transport and Logistics Forum (DTLF), particularly through e-documentation tools and real-time tracking.

Simultaneously, research like Pernille et al. (2019) and Gnap & Surovcik (2015) have underscored the significance of public-private partnerships and stakeholder collaborations. These partnerships have been essential in establishing new terminals, expansion of rail freight capacity, and the introduction of cutting-edge technologies such as autonomous handling equipment and intelligent container routing.

Challenges in intermodal transportation

One of the most cited challenges is the absence of infrastructure harmonization among EU member states. Inefficient cargo flows and lengthier transit durations are caused by the disparity in infrastructure quality between Eastern and Western Europe (Islam & Dinwoodie 2019). In multimodal integration, poor last-mile connectivity remains a hurdle, especially between rail terminals and major highways (Liedtke & Wittenbrink 2020).

Additionally, a major barrier to the efficient operation of intermodal transportation is regulatory fragmentation. Each member state upholds unique technical standards, safety regulations and administrative procedures which complicates cross-border logistics. This lack of harmonization raises transaction costs and delays, particularly in interoperability and custom clearance (Macharis & Van Mierlo 2017).

Poor coordination and lack of strategic alignment leads to the dispersion of stakeholder interests, involving trucking companies, public agencies, rail operators and terminal authorities. Panagakos et al. (2020) argues that this misalignment frequently leads to underutilized infrastructure, overlapping investments and trouble in achieving economies of scale.

Despite its growth, intermodal transportation confronts several obstacles across the EU. Turi et al., (2024) analyzed Romania's intermodal sector identifying challenges like poor connectivity, terminal congestion and insufficient public investment.

Macharis and Bontekoning (2004) evaluated operational research contributions to intermodal transport, emphasizing the necessity of strategic planning and optimization to resolve inefficiencies and enhance system performance.

Lastly, the growth of infrastructure in outlying or less economically developed areas is constrained by financial barriers like high initial investments of equipment and intermodal terminals. To close this financial gap, Pernille et al. (2019) highlighted the need of public-private partnerships and long-term policy support.

Policy implications and competitiveness

Intermodal freight competitiveness is greatly impacted by transport policies. Macharis et al., (2014) examined Belgium's transport policies highlighting the ways in which subsidies, terminal locations and internalization of external costs impacts the appeal of intermodal choices.

Taking into notes both internal and external considerations, Janic (2007) examined the total costs of intermodal versus road freight transport. The study concluded that intermodal transport might become more competitive by internalizing external costs.

A recent study by Bergqvist and Monios (2021), points to the 'institutional asymmetry' between the peripheral regions and the main EU transport routes. They argue that whereas policy like TEN-T has been successful in boosting investments in strategic corridors, they have also widened the development gap for smaller nations and less connecting areas, weakening overall intermodal competitiveness.

Furthermore, Aljhoni and Thomson (2019) highlight the need for multi-level governance in designing policies, especially for urban intermodal integration. Stakeholder uncertainty and fragmented implementation strategies arise from local policies pertaining from zoning, truck access, and noise regulations frequently clashing with national or EU level transport aims.

Another obstacle identified in the literature is the absence of performance-based evaluation frameworks for assessing the efficacy of policy interventions. Nikitas et al. (2021) suggested developing harmonized KPI's (Key Performance Indicators), for inter modal policy evaluation, which would improve transparency and enable data-driven modifications over time.

In response to these challenges, Bosch and Kuipers (2020) propose a more participatory approach to EU transport policymaking. Their research shows that the chances of policy acceptance and long-term competitiveness are significantly increased when industry stakeholders, city authorities, and logistics companies are included early in the planning process.

Technological innovations and Digitalization

Digital technology integration plays an important role in the development of intermodal transportation. Kine et al. (2022) conducted a systematic evaluation of enabling technologies, identifying the extensive use of wireless communication, sensors and web-based platforms. They also discussed how these technologies can potentially be used in low-income nations.

Caris et al. (2013) put a new research agenda emphasizing on decision making support systems in intermodal transport, highlighting the importance of information and communication technologies in improving decision making processes.

Gupta and Singh (2021) state that blockchain technology is gaining traction in intermodal transport for its ability to enhance traceability, eliminate document fraud and boost trust in logistics network. Similarly, operators can do predictive maintenance and dynamic rerouting by using IoT based telematics systems to track container status, location and conditions in real-time (Chpra & Sodhi 2019).

Gonzalez Feliu & Morana (2020) emphasized that digital twin technology is being investigated to improve capacity planning and stimulate intermodal terminal operations. These stimulations can optimize with contingency planning, bottlenecks predictions, and space utilization, especially for large-scale multimodal hubs.

Automation also plays an important role in enhancing terminal efficiency. Pan et al. (2020) discovered that automated cranes, autonomous guided vehicles (AGVs) and robotic handling systems can drastically reduce Labour costs and turnaround times, although costly capital investment remains an obstacle in widespread adoption in small and mid-sized terminals.

Despite technological advancements, lack of standardization and interoperability remains a major obstacle. Data sharing among many stakeholders and transport modes is difficult since many logistics systems still function in silos. Smaller businesses often struggle to meet the technical and financial requirements for digital adoption (Zuidwijk & Veenstra 2020).

Sustainability and Environmental considerations

It has been demonstrated that intermodal transport can reduce its effects on environment. In their examination of sustainability, Behrends and Floden (2012) explored the facts that shifting freights from road to intermodal can significantly reduce the impact of greenhouse gas emissions and congestion.

Janic (2008) assessed the performance of European long intermodal trains, emphasizing their environmental advantages and efficiency.

According to Chowdhury & Srai (2021), the system's operational efficiency and technical maturity have significant impacts on environmental benefits of intermodal transportation. The advantages of sustainability may be undermined by inefficient transshipment procedures and outdated terminal equipment because of increased fuel consumption and larger cargo idling times.

Urban sustainability has also gained attention. Russo and Comi (2020) state that intermodal transportation can reduce last-mile emissions and alleviate urban congestion. This is particularly important for urban dense centres where intermodal terminals are located near ports and rail hubs.

Christodoulou and Christidis (2021) highlight the importance of integrating of environmental indicators into the formulation of transport policy. They propose assessing infrastructure projects and funding eligibility using performance based environmental indicators, like emissions per ton-kilometers.

Challenges remain, however, Woxenius (2021) argues that if intermodal terminals infrastructure development is not controlled within a broaden sustainability framework, it may contribute to biodiversity loss and land use conflicts.

Furthermore, Tsamboulas et al. (2016) warns that sustainability goals must be linked with political wills and long-term investment strategies, particularly in less developed EU regions.

Operational Efficiency and Infrastructure

For intermodal transportation to be successful, operational efficiency is crucial. Ishfaq and Sox (2010) investigated how operational, financial and service issues in intermodal logistics concluded that resolving these challenges is essential for enhancing system performance.

Limbourg and Jourquin (2009) concentrated on optimal locations for rail-road terminals in Europe, emphasizing the need of strategic infrastructure placement for enhancing intermodal transport efficiency.

In benchmarking research on European intermodal terminals, Oliveira and Santos (2021) discovered wide variability in terminal efficiency, especially between Western Europe and developing regions of Eastern Europe. Their study underlined the need for standardized Key Performance Indicators to measure throughput, reliability, and service quality across terminal operations.

The lack of automation in small and mid-sized terminals imposes another challenge. Pan et al. (2020) report that, automated stacking cranes, self-driving vehicles and smart sensors can significantly lower human error, enhance handling speed and reduce operational costs. However, widespread deployment is limited due to high investments costs and lack of technical capacity.

Last but not least, Gonzalez-Feliu & Morana (2020) highlights the role of simulation tools and digital twins in improving infrastructure planning. Planners can anticipate congestion, and assess different investment scenarios in advance.

Methodology and Research methods

The philosophical orientation of this research is *interpretivism:* it emphasizes the subjective nature of reality and the importance of understanding social phenomena through the perspectives of the research participants. This research adopted a *qualitative research design combining systematic literature review, case study analysis and semi-structured interviews* to examine key challenges and opportunities in the intermodal transportation in the EU.

Systematic literature review was conducted to investigate the theoretical and empirical foundations of the intermodal transportation. WOS, Scopus and many peer reviewed journals were used to identify challenges and opportunities.

The selection criteria included relevance to intermodal transport in the EU, publications within the last 20 years, and contribution to key subjects like policy frameworks, sustainability and technology integration.

Table 1 presents the main criteria of the systematic literature review that served as the conceptual basis-framework for the research.

Table 1. Main Criteria of Systematic Literature Review: Conceptual Framework

Themes/ Codes	Key Findings/ Descriptive result and interpretation in text	Implications/ Criteria to be addressed
1.Challenges in Intermodal Transportation	Fragmented regulations, infrastructure disparity and lack of coordination between modes	Need for harmonized standards and collaborative planning mechanisms.
2. Policy implications and competitiveness	Policies impact modal shift and competitiveness, differential enforcement weakens integration	Stakeholder participation and harmonized policy frameworks are essential for competitiveness.
3. Technological innovations and digitalization	Digital tools like IoT, blockchain and automation are transforming operations, but adoption varies	All EU regions must invest in digital trainings and compatible systems.
4. Sustainability and Environmental considerations	Intermodal transport reduces emissions but depend on cleaner energy use and system efficiency	Integration with financing, policy and technological advancements is necessary for sustainability.
5. Operational efficiency and Infrastructure	Infrastructure performance is uneven, Terminal location and automation are key drivers	Efficiency requires performance measurements and strategic infrastructure investments.

Sample Justification

The cases for this study were selected based on their relevance to the research objectives of assessing the efficiency and sustainability of intermodal transport in the EU. The selected cases include Germany, Poland, Spain, the Netherlands and Italy that represent both successful implementations and ongoing challenges in integrating multimodal logistics systems. This diversity allows for a comprehensive analysis of the barriers and opportunities for intermodal transport across different EU contexts.

Furthermore, the *data sources* were chosen for their reliability and the availability of detailed information on policy, infrastructure, and technology, ensuring that the study provides an accurate reflection of the current state of intermodal transport in the EU.

Research Instrumentation

This study employed *semi-structured interviews* as the primary data collection method. Semi-structured interviews allow for flexibility in data gathering, providing participants the freedom to elaborate on their experiences and insights while ensuring that specific research questions are addressed. A questionnaire was used as a guide to ensure consistency across interviews and to capture relevant data on the technological, operational, and regulatory dimensions of intermodal transport in the EU.

The *criteria for participants (Experts) selection* were based on their direct involvement with or expertise in intermodal transport. Specifically, 10 experts from various sectors of the transportation industry were selected based on the *following indicators:*

- *Professional Role*: Informants included policymakers, logistics managers, and sustainability consultants with direct experience in intermodal transport operations, regulation, and environmental sustainability.
- *Experience:* Informants had 2-5 years of professional expertise in their respective fields, ensuring they could provide informed and relevant insights.
- *Educational Background:* held advanced degrees in fields such as business administration, logistics, public policy, or transportation, ensuring a high level of knowledge and competence.

Logic and Design of the Research

The design of this research follows *a qualitative approach* aimed at gaining in-depth insights into the challenges and opportunities of intermodal transport in the EU.

The *semi-structured interview design* allows the researcher to explore specific areas of interest while maintaining the flexibility to follow up on emerging themes or responses. This approach facilitates a rich understanding of the factors influencing efficiency and sustainability within EU intermodal logistics systems.

The research logic is grounded in the assumption that expert perspectives will provide valuable context and reveal the operational, institutional, and technological barriers to achieving seamless multimodal integration.

Additionally, expert opinions will inform an understanding of the role of EU policies and regulations in shaping the future of intermodal transport.

The research process was guided by *descriptive research design.* It should be stressed that the main purpose of a descriptive research design is to describe the situation or case of the research object.

This methodological approach served us as the most appropriate and reflective of our research question.

Presentation of the Research Procedure

Participants: 10 experts in the field of intermodal transport were selected, including 4 policymakers, 3 logistics managers, and 3 sustainability consultants.

Data Collection Method: The interviews were conducted virtually using the Zoom platform to accommodate geographical dispersion and overcome practical limitations. Each interview lasted between 45 to 60 minutes, providing ample time for in-depth discussion.

Timing: Interviews were conducted between June and July 2024, a period during which the industry faced several significant regulatory changes in the EU, allowing the research to capture current perspectives on emerging challenges.

Interview Structure

The semi-structured nature of the interviews allowed for flexibility in responses, while the questionnaire ensured that *core topics* such as **policy**, **technology**, and **logistics** were consistently addressed.

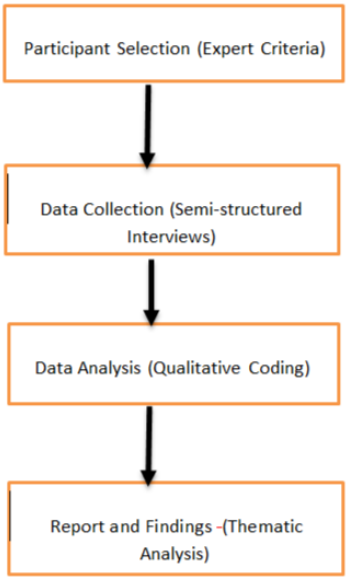

Fig 1. Research Design and Process Flow

Content Analysis: Interview Data, Coding, Categories, and Sub-Categories

Data Analysis Method

A *thematic analysis of interview transcripts* followed Braun and Clarke's six-step approach. This involved:

Reading and rereading the transcriptions constituted the first step of data familiarity.

Initial codes emerged from scanning meaningful parts of the data.

A researcher develops *themes through the process of collecting similar codes into groups*.

The researcher *conducts theme assessment which leads to the finalization of appropriate themes*.

Defining and naming themes. The final report contained participant themes together with their quotations.

Categories and Sub-Categories Identified: The theme development process alongside coding methods resulted in identifying four distinct areas with their corresponding *sub-categories*. *Regulatory Barriers*: National policies do not match up across EU borders which results in failure to coordinate intermodal transport systems between different member states. Quantum bureaucracy triggers unacceptable time delays when project execution occurs because of prolonged decision processes together with entangled

regulatory paperwork. *Technological Opportunities:* Digital Platforms represent the combination of IoT technology and blockchain capabilities for monitoring and improving product delivery routes. Actively managed vehicles and robots possess the ability to enhance operational efficiency in intermodal logistics routes. *Coordination Challenges*: The integration between transportation networks remains inadequate because transport modes lack proper physical connectivity together with inclusive digital capabilities. Public and private entities fail to maintain alignment during intermodal transport operations. *Sustainability Considerations:* Intermodal transport serves as an important factor for lowering carbon emission levels. Intermodal transport serves as an important factor for lowering carbon emission levels. *Green Technologies:* Adoption of sustainable technologies, such as electric trucks or biofuel-powered ships.

Table 2. Summary of Key Challenges, Opportunities, and Implications in EU Intermodal Transport

Theme	Category	Example Quote
Regulatory Barriers	Divergent safety and customs rules causing delays	National-level differences in safety standards are a major cause of inefficiency.
Technological Opportunities	IoT platforms and automation enhancing logistics	Automation will be the future, but we lack standard infrastructure right now.
Coordination Challenges	Lack of multimodal terminals and investment misalignment	Private and public sectors do not align their investment strategies effectively.
Sustainability Considerations	Green technologies (electric trucks, biofuel vessels)	More funding is needed to make sustainable transport practical across all regions.

Results and Discussion

The most common obstacle operating across EU member states emerged from diverse **regulatory systems existing independently**. Participants recognize that variable safety requirements together with emission standards and customs rules result in major operational delays which hurt transport efficiency between countries. The participants identified bureaucratic delays as a major problem since extended review periods for infrastructure planning and environmental implementation required to complete intermodal solutions.

Technological Opportunities: Multiple experts considered digital platforms and IoT systems as major logistics optimizers that improve real-time coordination capabilities. Standardized systems must exist between modes to accomplish full integration. The industrial sector viewed automation as a promising technology of the future. Various participants anticipated automated systems to appear in port terminals and self-driving trucks but the readiness of underlying infrastructure was considered uncertain.

Coordination Challenges: The lack of sufficient infrastructure proved to be the main reason organizations faced coordination challenges. A lack of multimodal terminals which should connect rail transport, road transport and maritime transport interfered with effective cargo transfer between EU member states. Public and private stakeholders faced limitations in their successful coordination due to non-aligned investment strategies and regulatory frameworks.

Sustainability Considerations: The group affirmed that intermodal transportation offers considerable emission reduction benefits mainly through rail and maritime transport substitution of road transport services. The participants stated that sustainable technology infrastructure needed better support because existing facilities were insufficient for electric vehicles and green ports. Green technological initiatives along with specific measures such as electric trucks and biofuel-powered vessels received high importance from study participants. Exponents of sustainable technology stressed that both financial support and government backing would enable these solutions to become practical options.

Conclusion

The **central research question** asked: *"How can the European Union enhance the efficiency and eco-friendliness of its intermodal transportation systems amidst existing logistical, regulatory, and technological challenges?* To answer this, the study pursued the **objectives** to arrive at the conclusion below.

The analysis discovered that members across the EU understand the strategic value of intermodal transport yet they have unsuccessful in bringing the system together at a national level. The differences between structural infrastructure and investment distribution across member states obstruct the development of a single network. The research investigates obstacles at operational, institutional and technical levels which obstruct successful multimodal coordination. Multiple sources from interviews and literary evidence revealed that fundamental obstacles in intermodal collaboration persist because member states maintain incompatible regulations and digital systems are not compatible between platforms and terminals and networks do not integrate well. The research evaluates how the Internet of Things (IoT) functions to enhance intermodal coordination. Expert interview thematic analysis exposed IoT as a powerful tool for real-time data sharing and predictive logistics while standards and governance policies act as obstacles. The examination investigates how environmental regulations together with EU policies affect sustainable freight transport. The Green Deal along with the Sustainable and Smart Mobility Strategy under EU-

wide programs has accelerated the progress toward greener transportation. Different regions execute practical implementation of these rules at highly different levels. The paper presents strategic advice for maximizing the effectiveness of EU-wide combined logistics system operations. The suggested strategic paths to enhance EU-wide logistics include the creation of connected digital networks and unified regulatory frameworks as well as raising public-private partnership involvement and establishing dry ports and intermodal terminals.

Recommendations

The following strategic recommendations stem from this research work to solve existing complications while maximizing intermodal transportation benefits across the European Union domain. These recommendations were developed to meet the needs of **four stakeholder groups: EU institutions, national policymakers, infrastructure investors and private sector logistics actors.**

Investment in Infrastructure Modernization

The target audience consists of EU Commission along with National Transport Ministries and Infrastructure Development Agencies. Targeted and substantial investment leads to the necessary improvement of infrastructure to eliminate operational bottlenecks and capacity constraints. Intermodal terminals require improvements which boost their efficiency when handling large volumes. Vertical expansion of rail freight systems through modernization projects that include both electric utility power and double-track lines. The necessary investment aims to develop improved transportation connections between ports and terminals and inland logistics facilities. Boosting physical infrastructure enables better speed reliability in transport services while creating conditions that will propel people to shift their transport options to rail or water.

Harmonization of Regulations across Member States

The target recipients of this proposal are EU Legislators together with European Council members and National Regulatory Bodies. Create and establish uniform rules that control the following aspects: Safety, emissions, and transport documentation. Customs procedures and digital compliance requirements. Standards for intermodal equipment include containers as well as handling machinery. Regulatory standardization guides industry towards reduction of administrative obstacles and delivers seamless cross-border activities as well as optimized European market logistics processes. Speed up transformation procedures that enhance intermodal logistics.

Operations EU Digital Strategy Units together with Transport Ministries and Logistics IT Developers make up the target audience for this proposal. Actions should include: The integration of both real-time data platforms and tracking systems should receive organizational support. Logistics planning together with freight handling operations will benefit from increased implementation of AI and IoT and automation systems. Organizations should establish common cyber security requirements and interoperability standards between different transport systems. The modern multimodal logistics system requires digital transformation because this enhancement creates better transparency alongside effective efficiency and predictive decision capabilities.

Support developments for dry ports and hinterland terminals throughout the nation

The target groups consist of Regional Development Authorities, Port Authorities together with Private Investors. Stimulate dry port development through: Public funding, incentives, and regulatory facilitation. Enhancing rail-road exchange system operations between seaports and interior consumption areas. National and EU Transportation Network-Tangent program administrators should integrate dry port facilities into their planning as part of corridor development. Dry ports serve a dual purpose by easing port congestion and by providing remote distribution centers for previously unreachable lands.

Foster Public-Private Collaboration and Knowledge Exchange

The target recipients include Logistics Companies together with Industry Associations and Municipal Governments and Research Institutions. Develop collaborative mechanisms such as: Sustainable transport infrastructure receives funding support through coordinated investment plans which unite different entities. Interdisciplinary platforms will help organizations to match their approaches and build multi-modal answer sets together. Shared innovation hubs for testing new technologies and sustainable practices. The implementation of intermodal transport needs public-private entities to work together for shared infrastructure ownership and combined resources and collaborative innovative efforts.

Strategic intermodal development needs to match requirements of the EU Green Deal initiative

The target group includes directorates from the EU Climate and Transport divisions together with Environmental NGOs and Urban Planners. The efforts to develop intermodal transport must enact the following functions: CO_2 emissions reduction targets. Urban air quality improvements and congestion mitigation. Every region must have equal opportunities to use sustainable transportation systems. Intermodal systems remain essential for the EU to reach its 2050 climate neutrality goal therefore these systems must follow long-term sustainable development paths.

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