

22<sup>nd</sup> International Conference  
on Transport Science

# ICTS 2026

MARITIME, TRANSPORT AND  
LOGISTICS SCIENCE

Book of abstracts



Slovene Association of Transport Sciences  
University of Ljubljana, Faculty of Maritime Studies and Transport  
University of Split, Faculty of Maritime Studies

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# **ICTS 2026**

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### **Abstract**

The air transport sector is the fastest growing sector in Europe. Advanced technological development has also accelerated the development of air transport urban mobility. The European Commission forecasts the use of "flying cars" and primarily an electric vertical take-off and landing (eVTOL) aircraft in urban areas by 2035. First steps of the implementation regarding to the technological, regulatory and safety framework are the basis for the implementation of Safety Management System (SMS) in aircraft operations in urban areas. Belgrade (Serbia), as the host of EXPO 2027, has the opportunity to promote the aviation operations of eVTOL aircraft, which is a general challenge for designers, civil aviation authorities (CAA), decision-makers, but also for potential users and industrial development in the future. The paper analyses all the necessary elements for the successful realization of demo and commercial flights during the EXPO 2027 exhibition in Belgrade by focusing on aircraft (eVTOL) and infrastructure (vertiports). After the EXPO 2027 exhibition, the results achieved in the field of abovementioned aviation issues could certainly improve the development of urban air mobility framework in Europe.

*Keywords: Aviation, eVTOL, vertiport, safety, urban mobility*

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## (5) TECHNOLOGY-ENHANCED INVENTORY RISK MONITORING AT DRY PORTS - A CONCEPTUAL FRAMEWORK FOR GEORGIAN BANKS

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### **Abstract**

The concept of dry ports is increasingly significant for a nation such as Georgia, as it holds the potential to function as a pivotal hub within the Middle Corridor. An advanced warehousing system is essential for the effective planning of operations, development, and services. In this regard, the integration of digital technologies is of particular importance. This study proposes a conceptual framework for technology-enhanced inventory risk monitoring at dry ports, with a specific focus on its potential relevance for Georgian banks. The framework considers connectivity infrastructures, such as 5G and low-power wide-area networks (LPWAN) (e.g., LoRa), as foundational layers that enable real-time stock measurement, environmental monitoring, and secure data transmission. These technologies can enhance transparency by bridging informational gaps between the physical state of inventory and financial risk assessment processes. Risk assessment and its early identification are advantageous not only for companies but also for the financial sector. Digital monitoring functions as an independent transparency layer within the logistics ecosystem. The applicability of the model depends on governance capacity, cost structures, and operational scale. This study contributes by linking dry port digitalization to structured inventory risk oversight and by identifying the institutional and economic conditions under which such technologies can improve risk management practices in emerging markets.

*Keywords: dry ports, inventory risk monitoring, 5G connectivity, LoRa networks, risk governance, Georgia*

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# **(7) SOLUTION OF NONLINEAR TRANSPORTATION PROBLEM: INFLUENCE OF STARTING POINT IN GLOBAL OPTIMIZATION BY BRANCH-AND-CUT METHOD**

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## **Abstract**

Nonlinear transportation problems (NTPs) frequently arise in various industries and are among the optimization problems with practical value. However, it is generally difficult to reach global optimality of the solution for these problems, even when using state-of-the-art search algorithms. For effective decision-making in an industrial environment, it is not only important that the NTP solution is exact and optimal, but also that such a solution is obtained within an acceptable time frame. The purpose of selecting a good starting point, i.e. an initial basic feasible solution (IBFS), when solving the NTP with an optimization algorithm is to decrease the number of iterations required to gain the optimal solution and consequently also reduce the associated computational time. The present article addresses the influence of starting point on solution of NTP in global optimization by branch-and-cut (BC) method. It focuses on the exact solution of NTPs formulated as nonlinear programming (NLP) optimization problems with non-decreasing objective functions defined by various nonlinear continuous and differentiable expressions. Based on solving reference NTPs found in the literature, a series of rigorous optimization tests were performed for IBFSs generated by several different conventional methods. The results achieved in the optimization tests were compared both between themselves and those from the literature, and towards the end of the article, some findings on the methods applied to generate IBFS were presented, indicating their suitability for solving NTPs with BC approach.

*Keywords: nonlinear transportation problem; initial basic feasible solution; nonlinear programming; global optimization; branch-and-cut method*

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# **(8) SOLUTION OF NONLINEAR TRANSPORTATION PROBLEM: OVERVIEW OF METHODS AND REAL-WORLD APPLICATIONS**

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## **Abstract**

Nonlinear transport problems (NTPs) are regularly addressed both as topics of basic research and as subjects of applications in industrial environments. Namely, the complexity of solving them to global optimality motivates numerous research efforts worldwide to develop efficient optimization methods, while their high practical value repeatedly drives new implementations in real industrial conditions. The paper tackles the solution of NTPs by overviewing relevant state-of-the-art methods and real-world applications. Along these lines, the present contribution aims to provide the professional and academic community with up-to-date information related to these areas. Following a brief introduction, the article proceeds with the overview methodology. In this work, the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) 2020 guidelines are employed to assure transparency and replicability of overview. Adherence to these guidelines ensured that the search focused on the most relevant and high-quality studies, while systematically excluding those that did not meet the criteria set for the overview. Supported with these methodological bases, the overview is then conducted, and findings are reported for both areas considered. The article ends with conclusions and suggestions for further studies.

*Keywords: nonlinear transportation problem; optimization methods; real-world applications*

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# **(10) AN ANALYSIS OF THE RECEPTION CAPACITIES FROM THE PERSPECTIVE OF MARITIME SAFETY IN THE PORT OF KORČULA (POLAČIŠTE)**

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## **Abstract**

Despite significant socioeconomic development and increased tourism activity, the island of Korčula currently lacks the necessary infrastructure to maintain stable growth and further expand its development opportunities. It primarily relates to the congestion in maritime and road traffic at the port of Korčula during the summer months, which compromises transport safety at land and sea, increases pollution, diminishes residents' quality of life, and jeopardizes the destination's sustainability. These concerns led to the decision to construct the new port of Polačište, prompting a comprehensive maritime safety study. This paper aims to analyse the data and evaluate the planning of the additional port reception capacity from a marine safety perspective, by elaborating on the decision to engage in passenger terminal migration to meet rising demand for services. Analysis of hydro-navigational, meteorological, and oceanographic data suggests that the new port could expand the Port of Korčula capacity by 10–20%, while relocating ferry and road traffic outside the city centre. This outcome would achieve the objectives of Polačište port construction in terms of maritime safety and sustainability. This research's main conclusions highlight the importance of a long-term, systematic approach to maritime infrastructure planning that considers the region's technical and social development aspects.

*Keywords: Korčula; Port of Polačište; maritime safety; sustainability; receiving capacities*

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# (11) DESIGNING A LOW-EMISSION LOGISTICS MARKETPLACE ECOSYSTEM: BUSINESS MODEL CHANGES AND STAKEHOLDER TAKEAWAYS

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## **Abstract**

This paper shares practical takeaways for organizations that want to build or use a low-emission multimodal logistics marketplace ecosystem. We use the Advanced Multimodal Marketplace for Low-Emission and Energy-Efficient Transportation (ADMIRAL) project, which develops a digital ecosystem for multimodal logistics and transparency into emissions. Our data comes from AS-IS and TO-BE Business Model Canvases (BMCs), stakeholder questionnaires, and focal group interviews. We analyze expected business model (BM) changes for three stakeholder groups: the marketplace owner, buyers and sellers of logistics services, and complementors (e.g., information technology (IT) developers, data providers, and integrators). Based on the findings, we present stakeholder-specific guidance on what to offer, how to integrate, which capabilities to develop, and how to think about revenue models. The results can support companies that plan to design, join, or scale similar logistics marketplace ecosystems.

*Keywords: ADMIRAL; logistics marketplace ecosystem; business model, stakeholders, changes*

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## **(12) APPRAISAL METHODS FOR TRANSPORT INFRASTRUCTURE PROJECTS: A REVIEW OF APPROACHES AND APPLICABILITY CONDITIONS**

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### **Abstract**

The development of transport infrastructure is crucial for modern countries as it generally contributes to economic growth, improved safety, and/or social cohesion. Transport infrastructure projects range from local road improvements to the construction of airports, ports, motorway sections, and other large-scale interventions. Regardless of the functional or geographical scope of a project, investment in transport infrastructure involves a wide range of activities, from planning to implementation, as well as diverse costs and benefits. To evaluate such projects, methods such as Cost-Benefit Analysis (CBA), simplified CBA, extended CBA (CBA+), and Multi-Criteria Analysis (MCA) are used. The choice of evaluation method depends primarily on the project's size and complexity, as well as the availability of data. This article analyses various approaches to evaluating transport infrastructure projects and identifies the boundary conditions under which each method is most appropriate in Slovenia.

*Keywords: transport infrastructure; project appraisal; Cost-Benefit Analysis (CBA), extended Cost-Benefit Analysis (CBA+), simplified Cost-Benefit Analysis, Multi-Criteria Analysis (MCA)*

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# (13) AI-ENABLED DYNAMIC ROUTE OPTIMIZATION FOR LAST-MILE DELIVERY: A LITERATURE REVIEW

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<sup>b</sup>*University of Ljubljana, faculty of Maritime studies and Transport, Pot pomorščakov 4, 6320 Portorož, Slovenia*

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## **Abstract**

Last-mile delivery (LMD) is a critical component of supply chain logistics, accounting for 30% of total logistics costs. It faces persistent challenges, including delivery delays, rising operational costs, and increased emissions, largely due to traffic congestion, limited parking availability, and insufficient integration of real-time data. In recent years, artificial intelligence (AI) and machine learning (ML) have been increasingly explored as promising tools to address these challenges, particularly through improved routing, cost reduction, and enhanced sustainability. This article presents a comprehensive literature review of AI-driven solutions for LMD, with the primary aim of assessing how and to what extent AI and ML techniques have been applied in this domain. Special attention is given to identifying and categorizing AI and machine learning methods used for dynamic route optimization, as well as examining how real-time data sources – such as traffic conditions, weather information, and customer demand – are integrated in existing research. The review covers peer-reviewed journal articles published between January 2020 and January 2026, and was conducted using the Scopus, TRID, ScienceDirect and Cobiss databases to ensure broad and systematic coverage. The findings indicate that AI-based approaches have significant potential to improve operational efficiency, reduce emissions, and increase customer satisfaction in LMD. However, current research remains fragmented, with limited focus on scalable solutions, advanced AI techniques, and the effective integration of multiple real-time data sources. These gaps highlight the need for future research to move towards robust, adaptable AI frameworks supported by comprehensive datasets and real-time data integration, which will form the basis for further advances in last-mile logistics.

*Keywords: last-mile delivery, artificial intelligence, dynamic routing, urban logistics*

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## (14) THE RED SEA CRISIS AND ITS IMPACTS ON THE MEDITERRANEAN CONTAINER PORT SYSTEM?

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### **Abstract**

Turbulent events in the Red Sea erupted toward the end of 2023, profoundly disrupting global maritime routes. As a result, the Mediterranean Sea has shifted from a transit corridor to a maritime cul-de-sac. Since late 2023, many container shipping lines chose to avoid the Suez Canal passage, leading to significant changes in the organization, connectivity, and port calls in the mediterranean container port system.

This paper presents a spatial analysis of these disruptions based on AIS data in the Mediterranean Sea. It further examines the strategic adjustments made by numerous container shipping companies in their services. It also raises the following question: is there truly a disruption in the servicing of Mediterranean gateway ports linked to the Red Sea crisis?

In the wake of the Red Sea crisis, the Mediterranean Sea appears to be evolving towards a more finely meshed configuration. A comparison between 2022 and 2024 reveals an increase in the presence of small and medium-sized shipping companies, which are making more frequent calls at secondary Mediterranean ports.

*Keywords: Type your keywords here, separated by semicolons ;*

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## (15) DECARBONIZING MARITIME PILOTAGE: LOW-EMISSION TECHNOLOGIES FOR PILOT BOATS IN THE BALTIC SEA

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### Abstract

The Baltic Sea is one of the world's busiest maritime regions, with approximately 2,000 vessels operating daily and handling a significant share of global maritime cargo flows. Ensuring maritime safety and environmental sustainability in this context represents a major challenge. Maritime pilotage remains indispensable for safe navigation and risk mitigation, including the prevention of collisions and oil spills. In addition, maritime pilots contribute to decarbonization efforts by influencing vessel routing and speed optimization. However, pilot boats themselves are a source of greenhouse gas (GHG) emissions, particularly in densely trafficked coastal and port areas.

This study investigates the potential for reducing the environmental impact of pilotage operations in the Baltic Sea through the adoption of low-emission technologies for pilot boats in Estonia, Finland, Latvia, and Sweden. The objective is to examine technological pathways for reducing CO<sub>2</sub> emissions across pilot boat fleets operating in the region. The analysis evaluates selected technological and operational solutions, including hybrid propulsion systems, energy-efficient HVAC technologies, digital operational optimization, and hydrodynamic efficiency improvements.

The study examines how technological innovation, national climate policies, and regional cooperation shape the transition toward low-emission pilotage services. The findings highlight practical pathways for reducing emissions from pilot boat operations and emphasize the importance of coordinated cross-border initiatives in supporting the decarbonization of maritime support services in the Baltic Sea region.

*Keywords: Maritime Pilotage; Maritime Decarbonization; Pilot Boats; Low-Emission Technologies; Baltic Sea*

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## (16) ASSESSING THE EQUALITY OF CHILD URBAN ROAD SAFETY IN SCHOOL ZONES: A CASE STUDY FROM SERBIA

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### **Abstract**

Children represent one of the most vulnerable groups in road traffic, particularly in the vicinity of schools, where exposure to traffic risks is high while the ability to perceive and respond to hazards remains limited. In Serbia, despite ongoing improvements in infrastructure and traffic education, the level of safety equality among children in school zones remains insufficiently examined. Spatial and social disparities between urban and rural areas, or between well-equipped and neglected school environments can generate unequal exposure to risk and undermine the goal of ensuring safe mobility for all. The study aims to assess the level of equality in child urban road safety within school zones by analyzing parental, educational, and institutional perceptions. A comprehensive survey was conducted among parents and teaching staff across municipalities in Serbia. The questionnaire is designed to capture perceptions of safety, exposure patterns, and institutional responsibility in ensuring safe school access. Descriptive and comparative statistical methods will be used to identify differences across location types (urban/rural), school infrastructure, and socio-demographic factors. It is expected that the findings will highlight significant inequalities in perceived and actual child safety levels within school zones, influenced by environmental, infrastructural, and behavioral determinants. The research aims to provide evidence-based recommendations for local and national strategies in traffic safety management, contributing to the development of fair and inclusive safety policies aligned with Vision Zero principles.

*Keywords: Child road safety; School zones; Safety equality; Urban road safety; Perception*

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# **(18) OF THE ROAD SURFACE CONDITIONS ON THE CHANGE IN THE COLLECTIVE RISK OF SECTIONS OF THE ROAD NETWORK OF THE REPUBLIC OF SERBIA**

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## **Abstract**

In road accidents, around 1.3 million people die annually in the world, while between 20 and 50 million people suffer various types of injuries. The most influential factor that affects the occurrence of traffic accidents is the human, followed by the road factor, in the system of human-vehicle-road-environment (HVRE) system. On the territory of the road network of the Republic of Serbia, there are numerous problems that, independently or in combination with other problems and unsafe behavior, contribute to the occurrence of traffic accidents. A special problem is the inappropriate way of moving a vehicle on the road under the influence of different road surface conditions. In this study, in order to determine the risk of traffic accidents on sections, the collective risk (CR) was calculated. The collective risk is the ratio of the absolute indicator to the length of the section (km). The weighted number of traffic accidents was used as an absolute indicator in the study, which represents the total number of accidents equalized by the severity of the consequences with appropriate weights depending on the severity of the consequences of the accident. Traffic accidents with fatalities have the greatest impact on the weighted number of traffic accidents. Subsequently, with the collected data on the number of traffic accidents on different road surface conditions, for each section, the impact of the change in the number of accidents on the collective risk was investigated using the linear robust regression method. The results obtained show that the deterioration of the road surface condition increases the collective risk of sections (especially in icy road surface conditions, where the average increase in collective risk is 45, which means that the consequences of accidents are more severe on icy roads). The aim of this paper is to determine the individual impact of different road surface conditions (dry, damp, wet, with snow and with ice) on the change in collective risk on sections of the road network of the Republic of Serbia.

*Keywords: ROAD Factor, Collective Risk, Linear Robust Regression, Traffic Accidents and Consequences.*

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# **(19) MARITIME GOVERNANCE IN TRANSITION: RE-EXAMINING THE IMO'S ROLE THROUGH THE LENS OF MARITIME DECARBONIZATION**

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## **Abstract**

The maritime sector has increasingly faced scrutiny due to its contribution to global greenhouse gas emissions. This has compelled the International Maritime Organization (IMO) to adopt a series of ambitious measures aimed at achieving the decarbonization of international shipping by 2050. Foremost among these initiatives is the IMO Greenhouse Gas (GHG) Strategy, which reaffirms the Organization's central role in shaping global maritime environmental policy and guiding the transition toward sustainable shipping. Nevertheless, uncertainty persists as to whether these international regulatory commitments will translate into effective, enforceable outcomes across diverse national and regional contexts. Maritime administrations play a decisive role in implementing IMO conventions at the domestic level, yet the degree of compliance varies considerably among States. Based on this premise, this study seeks to examine how the IMO functions to support state accountability and compliance. The research adopts a Straussian grounded theory approach to investigate the institutional and relational dynamics that influence the implementation of IMO-led decarbonization measures. A qualitative design combining document review and analysis, semi-structured interviews, and a survey questionnaire is applied to capture insights from diverse maritime stakeholders. The findings indicate a fundamental shift in the IMO's role from a traditional rule-making forum to a network enabler that promotes collaboration, capacity development, and collective accountability across the maritime sector. However, the analysis also underscores the necessity for enhanced enforcement powers to secure compliance and reinforce the credibility of global regulatory outcomes.

*Keywords: International Maritime Organization; maritime governance; decarbonization; grounded theory; network governance; network enabler; international maritime law*

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## **(20) GUIDELINES FOR THE POTENTIAL INTRODUCTION OF CROWDSHIPING INTO THE DELIVERY CONCEPT OF LCL SERVICES**

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### **Abstract**

Cost-efficient, time-optimal, and environmentally sustainable goods delivery is a key objective for many businesses, including the intermodal transport of small shipments by LCL (Less-than-Container Load) operators. One of the most challenging aspects of transport organisation is last mile delivery, which often incurs high costs, emissions, and time consumption relative to the distance travelled. To address these challenges, alternative delivery models have emerged to supplement or replace traditional services. Among these is crowdshipping (CS), a concept in which individuals travelling along specific routes transport packages in exchange for compensation. Each consolidated LCL container includes numerous smaller shipments destined for geographically dispersed locations, requiring a highly agile and efficient delivery network. As every LCL container differs in the content and destination of its small shipments, operators must continuously optimise delivery planning to minimise costs, delivery times, and environmental impact. This paper provides guidelines for the potential future integration of the CS concept into the dynamic delivery systems of LCL operators and analyses methods for coordinating and guiding future delivery approaches in complex intermodal transport chains for small shipments.

*Keywords: LCL; Crowdshipping; Last-Mile-Delivery; Guidelines*

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## **(21) MULTI-CRITERIA ASSESSMENT OF COASTAL SENSITIVITY TO MAJOR OIL SPILLS IN THE NORTH ADRIATIC SEA**

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### **Abstract**

Despite global trends towards renewable energy sources, oil products remain prevalent and resilient, due to their feasible incorporation into the IMO's 2050 net-zero emissions strategy, as well as the intermediate 2030 and 2040 targets. However, their environmental impact, particularly in the event of spills, poses significant risks to coastal ecosystems and human activities. This is especially critical in enclosed coastal zones such as the northern Adriatic Sea. Building on an earlier sensitivity assessment of the northern Adriatic coastline, the NAMIRS project, as part of the EU Civil Protection Mechanism, gathered expert evaluations of coastal sensitivity factors identified and located along the shores of Italy, Slovenia, and Croatia, the three partner countries in the project. Contributors to each focus group included professionals from marine and maritime industries, environmental protection agencies, marine research institutions, spill response services, relevant non-governmental organisations, and elected officials. The collected data were statistically analysed to support the development of a coastal sensitivity map. This study applied a multi-criteria evaluation of estimated sensitivity criteria categorised into socio-economic, geomorphological, and environmental groups using a Distance-based Analytic Hierarchy Process (DAHP) decision-making model. The reliability of the experts' assessments was validated by comparing the NAMIRS methodology with the results of the DAHP analysis. The results highlight the dominance of environmental criteria and inconsistency in stakeholder assessment on a national level, which does not show on the international level.

*Keywords: Oil spill; ESI; Coastal sensitivity mapping; Multi-criteria evaluation; Statistical analysis*

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## **(22) BRIDGING DIAGNOSTIC LIMITATIONS: A STRAY FLUX METHOD FOR COMBINED FAULTS IN MARINE INDUCTION MOTORS**

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### **Abstract**

Induction motors are essential components in marine propulsion and auxiliary systems, where operational reliability and early fault detection are critical for ensuring safe and efficient vessel performance. Among various condition monitoring methods, stray flux signature analysis has emerged as a promising non-invasive diagnostic technique for detecting both electrical and mechanical faults, such as bearing faults and broken rotor bars. By monitoring variations in the stray magnetic field surrounding the motor, this method provides valuable insight into the internal electromagnetic state without physical intrusion or significant modification of the existing system. A detailed review of the literature reveals a notable research gap. There is a lack of scientific studies focused on the application of stray flux-based detection methods for induction motors operating in maritime environments. Furthermore, while separate investigations into bearing faults and broken rotor bars exist, the simultaneous detection of these faults have been rarely studied. This research aims to address this gap by experimentally validating a stray flux method capable of identifying both bearing and broken rotor bar faults combined. In the proposed approach, flux sensors are strategically positioned to record, enabling the identification of characteristic fault signatures using Fast Fourier Transform. Future research will adapt this diagnostic method to the specific challenges of the maritime reality, including fluctuating load profiles, vibration, noise, and electromagnetic interference from other onboard systems. Ultimately, extending stray flux signature analysis to maritime applications could enable the development of predictive maintenance strategies, significantly enhancing the safety and reliability of modern vessels.

*Keywords: Induction motor; broken rotor bar; bearing fault; stray flux; maritime systems*

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## (24) ADVANTAGES OF IN-SITU RAMAN SPECTROSCOPY IN MARITIME AFFAIRS, WHY MAKE IT PORTABLE?

**Nediljko Kaštelan<sup>a</sup>, Ivan Pavić<sup>a</sup>, Marina Laušić<sup>a</sup>, Mile Ivanda<sup>b</sup>**

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### **Abstract**

The maritime sector integrates multiple engineering and scientific disciplines, each contributing to the optimization of vessel performance, structural integrity, and environmental compliance. Achieving continuous operational improvements requires extensive data acquisition and analysis in order to monitor materials and processes in complex marine environments. Various techniques are used; among these, Raman spectroscopy has emerged as a powerful, non-destructive tool for many maritime applications, including material characterization, corrosion analysis, antifouling studies, and engine performance analysis. However, current practice usually involves laboratory measurements on samples collected remotely, a process that can introduce uncertainties from handling, contamination, transportation, and environmental exposure. In this study, we examine the potential of in-situ Raman spectroscopy to address these limitations and improve data fidelity. Our assessment demonstrates how field-deployable Raman systems can minimize sample degradation, reduce processing time, and improve data reliability, thereby enhancing diagnostic precision and operational efficiency. Compared to conventional approaches, portable Raman measurements offer a way to achieve faster, more accurate material assessments that are directly connected to their environmental context. These findings highlight the broader potential of compact spectroscopic technologies to transform monitoring and research practices across the maritime sector.

*Keywords: Spectroscopy; Raman; Maritime; In-situ*

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## **(25) BUSINESS MODEL DIVERSIFICATION OF EV MANUFACTURERS WITHIN THE BIDIRECTIONAL CHARGING ECOSYSTEM**

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### **Abstract**

The rising number of electric vehicles (EVs) simultaneously increases dependence on the energy sector and additional strain on existing infrastructure. In turn, EVs can be used in a smart way, solve this self-created problem, stabilize the grids and improve the utilization of renewable energies. This is made possible by bidirectional charging, a technology enabling to charge, as well as to discharge the EV. Thus, a new economic value can be created within the transport sector by storing energy back into a house, building or the grid. While an offering for bidirectional charging requires the participation of various actors who need to align and develop interfaces, EV manufacturers are of particular interest in this ecosystem. Contributing the main and most expensive asset, the EV manufacturers are confronted with possible battery degradation and granting permission to use the EV for purposes other than mobility. Therefore, they are interested in capturing a share of the bidirectional charging value pie. However, the value-creating effect actually occurs outside the EV manufacturer's business model. This raises the question of how manufacturers can adapt to still participate. Using qualitative in-depth interviews, this study seeks to analyze potential strategies for the EV manufacturers and how they adapt bidirectional charging to diversify their business models. The results reveal varying levels of awareness to participate and emphasize the establishment of services and data exchanges for value capture instead of using bidirectional charging merely as technical feature.

*Keywords: bidirectional charging; vehicle to grid; electric vehicle manufacturer; business model innovation; energy-mobility integration*

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## **(26) LIABILITY OF MULTIMODAL TRANSPORT OPERATORS – CONTRACTUAL CLAUSES VS. (INTER)NATIONAL LAW**

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### **Abstract**

In multimodal transport, goods are carried from origin to destination (under a single contract) using two or more modes of transport (maritime, inland waterway, air, road, or rail). As the predominant form of transport in international trade, multimodal transport plays a vital economic role. However, its rapid economic and technological development has not been matched by a corresponding evolution of its legal framework, particularly regarding the liability of multimodal transport operators for damage to goods during carriage. This issue is of major importance for numerous stakeholders in international trade, including carriers, freight forwarders, cargo owners, and both liability and cargo insurers. While unimodal transport (where goods are carried using only one mode of transport) is governed by international conventions regulating carrier liability, no such convention currently exists for multimodal transport. In addition, national legal systems approach this issue differently, resulting in a lack of global uniformity and legal predictability. Consequently, parties to multimodal transport contracts must regulate liability issues through contractual clauses, ensuring their consistency with the mandatory provisions of the applicable law and, in some cases, with unimodal transport conventions, which may exceptionally extend to certain stages or types of multimodal carriage. In the absence of such consistency, contractual provisions are invalid and inapplicable. This paper examines the content of commonly used contractual clauses on the liability of multimodal transport operators and their applicability considering mandatory provisions of unimodal international conventions and selected national laws. Such analysis allows for a clearer understanding of the actual scope and effect of these clauses and contributes to completing the picture of the legal framework governing multimodal transport operator liability for damage to goods.

*Keywords: multimodal transport contract, liability of the multimodal transport operator, international transport conventions*

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## **(28) A GENERIC MODEL FOR EVALUATING VERTICAL FLIGHT (IN)EFFICIENCY IN CLIMB AND DESCENT: A CONDITIONAL COUNTERFACTUAL ACTUAL-OPTIMAL ASSESSMENT**

**Matej Soldo Jocić<sup>a</sup>, Biljana Juričić<sup>a</sup>, Zvonimir Rezo<sup>b</sup>, Sanja Steiner<sup>b</sup>**

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### **Abstract**

Vertical Flight Efficiency (VFE) has become a prominent research focus within Air Traffic Management (ATM) due to its significant operational, economic, and environmental implications. This study presents a generic, scalable model for evaluating vertical flight (in)efficiency in the climb and descent phases by detecting and quantifying level segments (LSs) and constructing a counterfactual “optimal” trajectory, conditioned on the presence of detected LSs and aligned with Continuous Climb Operations (CCO) and Continuous Descent Operations (CDO) principles. The model quantifies inefficiencies in both absolute and relative terms, reporting impacts on fuel consumption, monetary costs, and multi-species emissions. A case study demonstrates the applicability and robustness of the approach. Results reveal significant variability in vertical inefficiencies, offering insights into potential operational improvements and environmental benefits achievable through optimized ATM strategies. The key contribution of this research lies in providing a reproducible and generic assessment framework that moves beyond LS detection to quantify their operational, environmental, and economic impacts via a conditioned counterfactual baseline. The model facilitates integration into airline and Air Navigation Service Provider’s post-operations dashboards, and supports evidence based, sustainability oriented ATM performance monitoring.

*Keywords: Vertical Flight Efficiency; Continuous Climb Operations; Continuous Descent Operations*

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# (29) ASSESSING THE ENVIRONMENTAL FRIENDLINESS OF FREIGHT TRANSPORT MODES IN THE EUROPEAN UNION: AN ECONOMETRIC AND DECOMPOSITION ANALYSIS

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## **Abstract**

This study uses an Extended Environmental Kuznets Curve (E-EKC) framework to assess the environmental performance of freight transport across EU countries, considering economic growth, logistics infrastructure, and freight transport modal composition. Using data from 27 EU countries from 2014 to 2023, the analysis examines the impact of Gross Domestic Product (GDP) per capita on freight transport-related CO<sub>2</sub> emissions, with logistics infrastructure included as a moderating factor. The study uses fixed-effects panel regressions to analyse the interaction effects of freight transport modes relative to road freight. Additionally, the Logarithmic Mean Divisia Index (LMDI) decomposition identifies the main drivers of transport decarbonisation. The findings provide no robust evidence of an EKC after controlling for country- and time-specific factors, showing that economic growth alone does not ensure decarbonisation in freight transport. Although multimodal freight transport has not emerged as a primary driver for reduced freight transport CO<sub>2</sub> emissions, the results indicate that logistics infrastructure influences the environmental performance of certain freight modes, particularly rail. Furthermore, the LMDI decomposition shows that recent reductions in freight transport CO<sub>2</sub> emissions in several high-income EU countries are mainly due to efficiency improvements rather than structural or modal shifts. These results highlight the need to integrate modal shift policies with relevant multimodal infrastructure upgrades, technological advancements, and measures to support the European Green Deal objectives and the 2050 net-zero target.

*Keywords: Environmental Kuznets Curve; Freight Transport; Logistics Performance; Modal Shift; Decarbonisation*

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## **(30) DYNAMIC DEA FOR REAL TIME URBAN FREIGHT EFFICIENCY UNDER TRAFFIC UNCERTAINTY**

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Slovenia*

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### **Abstract**

Urban freight transportation is a vital component of modern cities, but it faces increasing challenges from traffic congestion, delivery delays, and environmental pressures. Accurately measuring and improving operational efficiency in these dynamic and uncertain environments remains a significant challenge. This study introduces a novel dynamic Data Envelopment Analysis (DEA) framework to evaluate the real-time efficiency of urban freight operations under varying traffic conditions. By treating each delivery vehicle or route segment as a decision-making unit (DMU) and incorporating temporal performance data, the model captures efficiency variations across different time intervals, providing a more realistic and actionable assessment than traditional static approaches. The methodology integrates dynamic DEA with stochastic traffic modeling, using sensor and historical traffic data to address uncertainty in travel times and operational conditions. Efficiency is assessed using multiple indicators, including delivery speed, fuel consumption, and load utilization, while scenario analysis evaluates performance under different traffic patterns. This approach identifies underperforming units and suggests strategies to improve fleet efficiency, resilience, and sustainability.

By applying advanced operations research techniques to practical urban logistics challenges, this framework provides a valuable tool for city planners and fleet managers aiming to optimize urban freight systems, reduce congestion, and enhance service quality. The results show that dynamic DEA offers deeper insights into operational performance, supporting more informed and strategic decision-making in complex, real-world transport networks.

*Keywords: Dynamic Data Envelopment Analysis (DEA); Urban Freight Efficiency; Traffic Uncertainty; Real-Time Performance; SBM.*

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## **(31) SYSTEMIC FAILURES BEHIND CARGO LIQUEFACTION ACCIDENTS: A HFACS-MA BASED ANALYSIS**

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### **Abstract**

Cargo liquefaction is a leading cause of catastrophic bulk carrier losses, often resulting in the total loss of the vessel, crew fatalities, and severe environmental consequences. While the physical mechanism of liquefaction is well understood, accident investigations consistently reveal that human and organisational failures that enable the acceptance of cargo with excessive moisture content remain insufficiently addressed. This study analyses nine major maritime accidents linked to cargo liquefaction. It systematically categorises causal factors extracted from official investigation reports using the Human Factors Analysis and Classification System for Maritime Accidents (HFACS-MA) framework. A total of 37 distinct causal factors were identified, of which 54% could not be fully categorised within the existing HFACS-MA taxonomy. The most recurring gaps relate to poor stockpiling and inadequate weather protection, resulting in wet cargo, missing data on the cargo's moisture content, a voyage plan unsuitable for adverse weather conditions, and the absence of independent inspection to verify the cargo's properties prior to loading on board. These findings reveal apparent structural limitations of HFACS-MA in analysing liquefaction-related accidents and indicate the need for additional categories representing cargo control and external factors accountability. Strengthening preventive measures requires focusing on the decision-making mechanisms for accepting cargo loading on board, where the risk associated with moisture in the cargo arises and where safety barriers most often fail.

*Keywords: bulk carrier safety; human and organisational factors; IMSBC Code; accident analysis*

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## (33) AIRCRACK.IO: A WEB-BASED PLATFORM FOR HAPS OPERATIONS AND PERFORMANCE MONITORING

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### Abstract

The growing interest in High-Altitude Pseudo Satellites (HAPS) as complementary infrastructure to satellite and terrestrial networks has created new demands for operational monitoring, performance evaluation and decision-support tools. This paper presents aircrack.io, a web-based application developed to support real-time and historical performance assessment of HAPS operations. The platform integrates diverse data sources, ranging from flight telemetry and meteorological inputs to payload performance indicators, into a unified analytical environment. Preliminary testing demonstrates the platform's capability to process multi-source datasets with high usability and reliability. The application supports both tactical monitoring and strategic post-mission analysis, providing insights relevant to system optimisation, planning and regulatory compliance. By bridging research insights and operational needs, aircrack.io contributes to the development of data-driven approaches to optimise HAPS performance and enhance system resilience. In that respect, this paper outlines the design principles, system architecture and implementation of aircrack.io, together with its analytical features and visualisation capabilities, demonstrating its potential as a comprehensive auxiliary support unit for HAPS operations and performance monitoring.

*Keywords: High-Altitude Pseudo-Satellites; HAPS; aircrack.io; auxiliary support unit; performance monitoring*

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# **(34) DECISION-MAKING IN THE AERODROME AIR TRAFFIC CONTROL BASED ON METEOROLOGICAL DATA: A CASE STUDY REVIEW**

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## **Abstract**

Meteorological conditions play a crucial role in ensuring the safety, efficiency and continuity of air traffic operations. Accurate interpretation and timely application of weather data are fundamental to decision-making processes within airport air traffic control. In this context, the paper analyses the role of meteorological information in operational planning and control, with emphasis on the identification, assessment, and practical application of weather factors that influence flight performance. The study outlines key meteorological phenomena relevant to air traffic and reviews primary data sources, including METAR, TAF and SIGMET reports. The Air Traffic Management Airport Performance (ATMAP) algorithm is applied to quantify the severity of meteorological conditions by assigning weighted coefficients to weather phenomena, enabling evaluation from both operational and strategic perspectives. Using real data from Ruđer Bošković and Franjo Tuđman airports, the research highlights seasonal patterns and local atmospheric characteristics that shape air traffic management decisions.

*Keywords: aerodrome air traffic control; aeronautical meteorology; ATMAP algorithm*

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# (35) MANEUVERING MARGINS IN CONFINED WATERWAYS: INTERPRETATION AND SIMULATION-BASED COMPARISON OF THE EVER GIVEN CASE

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## Abstract

The continued growth of container ship capacity has resulted in Ultra Large Container Ships (ULCS) exceeding 24,000 TEU, with vessel lengths reaching 400 m and conceptual designs proposing even larger dimensions. Although economic efficiency has improved, propulsion power and maneuvering authority have not increased proportionally with displacement and characteristic length. This structural scaling imbalance reduces dynamic control margins in confined waterways, where navigation is constrained by limited channel width, shallow-water effects, and speed restrictions. Under such conditions, wind-induced yaw moments, bank interaction forces, and squat effects are amplified, while reduced speed through water diminishes rudder effectiveness. The combined effects of increased yaw inertia, declining power-to-displacement ratio, and constrained propulsion responsiveness narrow the recoverable maneuvering envelope of mega-container vessels. The grounding of the *Ever Given* in the Suez Canal represents a representative case in which these coupled mechanisms manifested under environmental loading.

This study applies an integrated Full Mission Simulation (FMS) and Fast Time Simulation (FTS) framework to interpret trajectory evolution and evaluate predictive maneuvering capability under confined-water constraints. While FMS enables realistic human-in-the-loop reproduction of hydrodynamic interactions, FTS provides force-based forward prediction of vessel response to environmental forces and control inputs. In contrast to conventional kinematic extrapolation tools, FTS anticipates coupled sway–yaw dynamics before critical trajectory divergence becomes observable. The results highlight the importance of dynamic, simulation-based assessment of maneuvering margins for future ULCS transits through narrow and shallow waterways.

*Keywords: Ultra Large Container Ships; confined waterways; maneuvering margins; bank effect; fast time simulation; Ever Given..*

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## **(36) UNDERSTANDING PASSENGER BEHAVIOUR AND WILLINGNESS TO SHIFT BETWEEN TRANSPORT MODES: REVIEW OF POSITIVIST AND INTERPRETIVIST PERSPECTIVES**

**Tomaž Kofalt<sup>a</sup>, Marina Zanne<sup>a</sup>, Aleš Groznik<sup>b</sup>**

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### **Abstract**

This paper explores the dual epistemological traditions (positivist and interpretivist) that underlie current research on passenger behaviour and willingness to shift between road passenger transport modes in the European Union (EU). It highlights the contributions of positivist approaches, such as Discrete choice modelling and Utility theory, in identifying quantifiable determinants of mode choice like cost, time, and infrastructure. In parallel, it reviews interpretivist research that foregrounds the emotional, social, and symbolic meanings embedded in mobility practices. By analysing empirical studies from both traditions, the review reveals how behavioural decisions are shaped by a complex interplay of structural, psychological, and cultural factors. It further advocates for integrated, mixed-methods approaches that combine statistical generalizability with contextual insight, offering a more comprehensive understanding of mobility choices across diverse EU contexts. The review concludes by identifying key research gaps (the underrepresentation of marginalised groups, the lack of longitudinal data, and the limited attention to digital platforms and ethical issues) and calls for a more inclusive, transdisciplinary research agenda to support sustainable and equitable transport policy in the EU.

*Keywords: passenger behaviour, modal shift, road passenger transport, positivist and interpretivist traditions, sustainable transport*

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## **(37) TRANSPORT POLICY CHALLENGES IN THE WESTERN BALKANS, WITH A FOCUS ON SUSTAINABLE TRANSPORT**

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### **Abstract**

The goal of integrating the economies of the Western Balkans (WB) into the European Union (EU) requires rapid and profound transformation of the transport sector to meet the ambitious targets of the EU Green Deal and the Sustainable and Smart Mobility Strategy (SSMS). This research applies the OECD Competitiveness Outlook (CO) framework and analyses policy challenges and governance gaps in three key sub-dimensions: planning and governance, regulation and connectivity, and sustainability. The primary obstacle to sustainable mobility is the region's deep dependence on fossil fuels, particularly in road transport, which accounts for the vast majority (99%) of domestic greenhouse gas (GHG) emissions. This problem is exacerbated by an ageing vehicle fleet, with many vehicles being 10-20 years old, and the negligible prevalence of zero-emission vehicles, which account for less than 1% of the total vehicle fleet. Successfully mitigating these environmental burdens requires urgent regulatory intervention, including tightening rules on the import of used vehicles and supporting the renewal of the vehicle fleet. Finally, addressing severe road safety issues—where fatality rates significantly exceed the EU average—and fostering robust legislative alignment and strong political will are paramount, reinforcing the perspective that new infrastructure alone cannot serve as a miraculous tool for solving underlying development and sustainability challenges.

*Keywords: Sustainable transport, Western Balkans, Transport policy*

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## (38) SHORE-BASED CAMERA VESSEL DETECTION AND TRACKING FOR TRAJECTORY ESTIMATION IN COASTAL WATERS

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### Abstract

This paper presents a real-time vessel detection framework as a basis for trajectory estimation to improve situational awareness and reduce collision risk in ports and coastal waters. By extracting vessel positions and motion, the system provides a foundation for trajectory estimation and collision risk assessment. Reliable maritime perception is challenged by scale variation, cluttered backgrounds and wakes, partial occlusions, and rapidly changing illumination and weather. Recent progress in single-stage detectors, particularly the YOLO family, enables high-throughput inference suitable for operational deployment while maintaining high localization accuracy. The framework combines YOLOv9 for object detection with DeepSORT for multi-object tracking, using a static, single-side-mounted camera. Trained for 90 epochs on the Split Port Ship Classification Dataset, the detector achieves a validation precision of 0.98, recall of 0.99, and mAP at IoU 0.5 of 0.99. To ensure operational performance, we evaluate the system's runtime efficiency; the detection pipeline operates at 22,82 ms per frame, while the tracking algorithm adds 36,21 ms, resulting in an average overall real-time processing rate of 16,94 FPS. The tracker maintains stable identities despite occlusions and appearance changes, and outputs motion trails for the past 64 frames. Qualitative results show accurate detections for vessels entering and leaving the Port of Split. Limitations include occasional false negatives and heavy occlusions. Future work will integrate explicit speed estimation and deploy a server-side application that fuses additional sensors and communicates advisories to onboard systems, with potential augmented-reality displays.

*Keywords: Vessel Detection; Video Surveillance; Yolo9; DeepSORT*

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## **(39) INVESTIGATION OF WILLINGNESS TO PAY FOR DEMAND-BASED CHARGING OF ELECTRIC VEHICLES IN URBAN AREAS**

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### **Abstract**

The expansion of the charging infrastructure for electric vehicles is one of the key factors in further establishing electric mobility. In many places, however, the problem is not the availability of the charging infrastructure, but rather its integration into daily life. With the help of a three-stage analysis, this study closes this research gap. In the first step, two focus group discussions are used to identify the needs of private and business users of charging infrastructure. These discussions confirm the research gap regarding integration into everyday life. The importance of charging in daily life becomes particularly clear for people who do not have their own charging facilities at home. To solve this problem, the second step involves developing possible solutions based on the identified challenges in focus group discussions. The focus here is primarily on charging vehicles during leisure and shopping activities, as well as additional services such as charging lounges. In the third step, a choice-based conjoint analysis with 245 participants is conducted to determine the willingness to pay for the developed solutions. It turns out that there is an increased willingness to pay for the integration of vehicle charging into leisure and shopping activities. High charging speeds and uniform payment options are also important. It can therefore be concluded that greater cooperation between charging station operators and retailers, including cross-selling, can increase the attractiveness of charging stations in line with demand.

*Keywords: choice-based conjoint analysis; willingness-to-pay; demand-based charging; electric vehicles*

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## **(40) RISK ANALYSIS OF A PROTOTYPE LANGUAGE TRANSLATION TOOL FOR RAIL CROSS-BORDER COMMUNICATION**

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### **Abstract**

The T4RAIL IT-SI project is an innovative initiative, coordinated by Rete Ferroviaria Italiana (RFI) in partnership with Italian and Slovenian railway operators and universities, aimed at promoting the digitisation of railway communications in the border area between Italy and Slovenia.

Currently, the B1 language requirement (CEFR) for train drivers limits rail interoperability and increases costs for cross-border services. To this end, the project objective is to experiment the use of a Language Tool (LT) for railway jargon called “Translate4Rail” on the Italy-Slovenia border. This tool will support communication between train drivers and signallers by translating predefined messages (PDMs).

Since these communications play a crucial role in railway safety, a risk analysis was conducted in accordance with Regulation (EU) No. 402/2013 with the dual purpose of identifying the safety measures necessary to safely conduct the field tests envisaged by the project and defining the safety requirements for the subsequent development of the LT required for its potential introduction into normal railway operations in the medium long term. Furthermore, this risk analysis can help to assess the impact of the digitalisation of railway procedures not only at the Italy-Slovenia border but also on border sections throughout the entire Single European Railway Area.

*Keywords: rail cross-borders; interoperability; communication; language translation tool, safety*

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# (41) ASSESSMENT OF LIGHT RAIL TRANSIT SYSTEMS BY ESTABLISHING SUSTAINABLE INDICATORS: A COMPARATIVE STUDY OF ANKENG AND DANHAI LRT IN TAIWAN

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## Abstract

As light rail transit (LRT) systems continue to expand across Taiwan, evaluating their performance from a sustainability perspective has become increasingly important. This study assesses the two existing LRT lines in New Taipei City through an integrated framework encompassing environmental, social, and operational dimensions. A structured set of sustainability indicators was developed to capture energy and environmental efficiency, service accessibility and inclusiveness, and operational performance, with visualization tools applied to clarify comparative strengths and weaknesses between systems. Results reveal that the two LRT lines exhibit differentiated sustainability profiles, each demonstrating advantages in distinct dimensions. To further contextualize these differences, stepwise discriminant analysis incorporating district-level socio-economic variables was conducted. The final model retained standardized comprehensive income and population density as key distinguishing factors (Wilks'  $\Lambda = 0.583$ ,  $p = 0.001$ ), achieving an overall and cross-validated classification accuracy of 82.8%. These findings suggest that LRT presence and performance are associated not only with urban density patterns but also with broader economic capacity.

By integrating sustainability indicators with statistical classification methods, this study provides a structured approach to linking transit performance with regional socio-economic characteristics. The framework offers policy-relevant insights for evidence-based evaluation and future rail-oriented planning in Taiwan and comparable metropolitan contexts.

*Keywords: Light Rail Transit; Sustainable Indicators; Discriminant Analysis; Urban Mobility*

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## (42) TRACES OF AID: MCDM MODEL FOR SELECTING THE OPTIMAL TRACKING TECHNOLOGY IN HUMANITARIAN LOGISTICS

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### **Abstract**

In today's world, the frequency and diversity of crisis situations demand rapid, accurate, and reliable control of aid flows, making tracking one of the key elements of humanitarian logistics (HL). Selecting the optimal tracking technology under such circumstances is a complex decision-making process, where technical capabilities, operational constraints, and field uncertainties intertwine. This paper applies a multi-criteria decision-making (MCDM) approach to the selection of tracking technologies in HL. The developed analytical framework enables a systematic and objective assessment of available solutions while taking into account the specific features of the humanitarian context. The results provide a foundation for applying the proposed MCDM model as a decision-support tool for selecting reliable and sustainable tracking technologies in HL.

*Keywords: Humanitarian logistics; crisis conditions; tracking technologies; digital innovations; MCDM*

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## **(43) DEVELOPMENT OF A STRATEGY FOR GREENING THE LAST MILE OF HOME DELIVERY SERVICES**

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### **Abstract**

The aim of this paper is to formulate a strategy for social enterprises to reduce the environmental impact of their mobility. The strategy contains measurable and comparable indicators that will be used to reduce the emission generated by home delivery of social services (HDSS). Based on a comprehensive literature review the possible actions are the following: electrification of the vehicle fleet, promotion of modal shift to greener transport modes, purchase of energy from greener sources, optimization of routing and scheduling to reduce fuel consumption.

We categorized HDSS based on type of service, road characteristics, organization of trips, availability of public transport and charging infrastructure. Relying on the categorization, different vehicle types are listed with features that could be used for HDSS. The output of this categorization is a decision-support matrix summarizing which transport mode is suitable for which service characteristics. In the paper we compare different trip planning tools. The main goals of trip planning are monitoring vehicle utilization, planning fixed trips in advance, re-planning demand-driven trips, optimizing single-vehicle and multi-stop trips, establishing multi-vehicle services, and minimizing unnecessary vehicle returns to the depot. By more efficient utilization of vehicles the carbon footprint can be reduced, enhancing the sustainability of HDSS.

*Keywords: strategy development; home delivery of social services; emission reduction; service categorization; trip planning tools*

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## (44) DETECTING ANOMALIES FROM ROADSIDE VIDEO STREAMS

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### Abstract

Machine learning has helped in advancing the automatic detection of anomalies in traffic data, but real-world applications remain challenging due to complex road networks, dynamic traffic behaviors, and environmental factors. This paper is a comparative evaluation of anomaly detection techniques and sheds light on when and why the evaluated methods struggle in real-world complex urban environments.

The study evaluates both classical and deep learning anomaly detection techniques on the detection of anomalies on the road.

The classical approaches which include filtering, DBSCAN clustering, masking and rule-based techniques, operate on tabular data obtained from a vehicle detection and tracking system, while the deep learning method, which leverages an autoencoder for temporal modeling, operates directly on the video stream. The methods were applied to real-world roadside traffic videos obtained from the StreetScene and MAVAD datasets. In addition the labels in the former dataset were refined such that the anomalies are common in both datasets.

Results show that the classical method achieved an 82% true positive rate on the tabular data and was affected by acquisition errors (anomalies that are errors of the detection and tracking system). The deep learning model, achieved an AUC of 83% after (data) augmentation and masking were applied. Classical methods fared better in the detection of object spatial location anomalies, while deep learning excelled at identifying slow-moving or unusual vehicles.

*Keywords: computer vision: anomaly detection: video anomaly detection: road traffic: road traffic anomaly detection*

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## (45) THE SMART CITY DATA PARADOX: A NEW GOVERNANCE MODEL FOR VALUING SMART MOBILITY ECOSYSTEMS

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### Abstract

Smart mobility ecosystems within Smart Cities consistently fail to achieve economic sustainability. While recognized as asset-heavy, current models overlook the ecosystem's most valuable intangible asset: aggregated data. This creates a paradox: cities are data-rich, but their mobility systems remain value-poor. This paper is theoretically grounded in the Resource-Based View (RBV), positing that data is the core strategic resource for a viable urban mobility ecosystem. However, its value remains unrealized due to a critical governance gap. We argue, using Transaction Cost Economics (TCE), that the lack of clear rules for data valuation and monetization creates high uncertainty and transaction costs, deterring private transport service providers (TSPs) from deep integration. This research investigates a new hypothesis: Smart Mobility viability could potentially be unlocked by redesigning data governance as the primary mechanism for economic value creation. We propose a novel theoretical framework where the city, as ecosystem orchestrator, actively curates and provides high-value, integrated data streams (e.g., real-time demand, predictive patterns). This curated data becomes a monetizable asset, enabling new business models for TSPs (e.g., dynamic service optimization) and creating new, shared value streams for the city as orchestrator. This paper models this data-centric governance structure, demonstrating how it minimizes transaction costs to unlock the latent economic potential of smart mobility data. Ultimately, only an economically sustainable ecosystem is a vital prerequisite to provide the robust, attractive alternatives necessary to achieve meaningful ecological goals like decarbonization and a systemic modal shift.

*Keywords: Transport Economics; Intelligent Transport Systems; Data Governance; Ecosystems, Urban Mobility; Smart City; Smart Mobility; Resource-Based View (RBV); Transaction Cost Economics.*

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## (46) DIGITAL READINESS AND SMART PORT INTEGRATION OF SMALL PORTS IN THE BALTIC SEA REGION

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### **Abstract**

The transition toward digital and data-driven logistics is reshaping maritime transport across Europe. While major ports increasingly adopt smart port technologies and integrated data systems, small and regional ports often face structural and institutional constraints. This study examines digital readiness and smart port integration in selected small ports in the Baltic Sea Region within the context of European Union digital transport policy, including the implementation of the electronic freight transport information Regulation and the European Maritime Single Window environment. The study applies a qualitative comparative case design based on structured documentary analysis of primary and secondary sources, including port development strategies, policy documents, and national maritime digital systems. A structured extraction protocol and a qualitative digital readiness assessment framework were used to ensure comparability across cases. The findings reveal differentiated digital transformation trajectories shaped not only by technology adoption but also by governance structures, institutional capacity, and participation in innovation networks. While several ports recognise digitalisation as a strategic priority, progress remains constrained by fragmented governance, limited financial resources, and restricted access to innovation programmes. The study shows that digital readiness in small ports is primarily governance-driven rather than technology-driven, highlighting the need for targeted policy support, capacity building, and stronger integration into digital logistics corridors.

*Keywords: small ports; digitalisation; Baltic Sea Region; smart ports; interoperability; governance*

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## **(47) ANALYSIS OF THE USE OF ELECTRIC VEHICLES IN THE EUROPEAN UNION**

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### **Abstract**

The prevalence of environmental issues has prompted a shift in focus from fossil fuel use to energy conservation. The presence of different types of transport that are more environmentally friendly and energy-efficient also has an influence on this. In the field of transportation, options are provided for the use of vehicles powered by alternative energy, in the form of electric energy. The deployment of these vehicles in areas with high population density has the added benefit of reducing air pollution, which is a major concern at present and is primarily attributable to motor vehicles.

Over the last decade, the electrification of mobility, especially passenger road transport, has been widely supported and promoted in many countries around the world. The objective of this paper is to present the current number of electric vehicles in the countries of the European Union, the trend of growth in the number of electric vehicles, as well as the forecast of their number for the upcoming period using correlation and regression analysis.

*Keywords: electric vehicles; ecology; European Union; forecast*

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## (48) COMPARATIVE ASSESSMENT OF DIGITAL SYSTEMS FOR CO<sub>2</sub> MONITORING IN MARITIME LOGISTICS

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### **Abstract**

The global transition toward carbon-neutral maritime logistics demands the deployment of advanced digital infrastructures capable of measuring, verifying, and optimising port-related CO<sub>2</sub> emissions. This study presents a comparative evaluation of digital solutions for emission monitoring currently implemented across European and Asian port systems. The analysis integrates documentary and technical evidence to assess the functional maturity, interoperability, and analytical capacity of existing platforms supporting data-driven decarbonisation. Special attention is given to integrated monitoring architectures that combine sensor-based data acquisition, automated analytics, and real-time visualisation within port management environments. The comparative assessment reveals distinctive regional orientations: European digital ecosystems demonstrate strong alignment with standardized reporting and regulatory compliance frameworks, while Asian ports emphasize operational intelligence, predictive modelling, and AI-enabled optimisation of energy flows. The findings suggest that bridging the European focus on regulatory precision with the Asian orientation toward adaptive automation can enhance both the reliability and agility of global CO<sub>2</sub> monitoring frameworks. Such convergence is essential for establishing interoperable, data-driven systems that enable consistent benchmarking, predictive management, and transparent reporting across the international maritime sector.

*Keywords: Port decarbonisation; CO<sub>2</sub> monitoring systems; digitalisation; automation; maritime sustainability; data interoperability*

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# **(50) BALANCING HEADWAYS AND PERFORMANCE REGIME COSTS: BUFFER SCHEDULING FOR SECONDARY-DELAY REDUCTION**

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## **Abstract**

Primary disruptions in single-track railway corridors can propagate as secondary delays to following trains. This work considers inserting planned buffers according to the Performance Regime (PR) penalty threshold, at train origin and/or following a disturbance, to limit the propagation of delays under standard headway and platform constraints. A timetable-adjustment framework is specified in which a finite set of buffer values is compared; each candidate timetable is evaluated with the same spacing/conflict rules used by dispatching, and the option with the smallest aggregate secondary delay is selected if able to improve the baseline timetable. A compact single-track passenger-freight case study is used to examine operational and financial effects: secondary delay by train, number and duration of reactive holds, and PR exposure derived from terminal delays (chargeable time above threshold, caps, and potential bonus windows). Expected outcomes include (i) reduction of secondary delays for the first followers by absorbing the risky approach at a platform rather than by mid-line checks, and (ii) improved PR exposure through reduced delays and avoided penalties. The framework remains lightweight, policy-agnostic, and readily applicable during timetable planning or day-of adjustments where the planned buffers can be traded against potentially larger unplanned reactionary delays.

*Keywords: Delays generation, Delays propagation, Timetable buffering, Performance Regimes, Operational and financial impacts*

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## **(51) DEFINING MARITIME TRAFFIC COMPLEXITY – CONCEPT DEVELOPMENT REVIEW**

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### **Abstract**

The term Maritime Traffic Complexity (MTC) has gained increasing attention as the maritime sector grows more complex. It is still a relatively new concept in the field of maritime safety and navigation. Despite its growing use, there is no unified definition or standardized framework for measuring or interpreting MTC. This conference paper provides a review of the current state of research on MTC, based on publications indexed in the Web of Science (WoS) and Scopus databases that delve into this concept. Through a brief literature review and qualitative content analysis, this study examines the various methodological approaches used to quantify and interpret MTC, including traffic flow modeling, spatial-temporal analysis, complex network theory, graph theory, and machine learning-based approaches. The paper highlights a variety of existing definitions of MTC and its scope. Existing gaps and inconsistencies in the conceptualization of MTC are identified, and a structured overview of current definitions and various parameters for measuring MTC is given. The results provide a foundation for harmonizing future research and developing standardized metrics for evaluating MTC, ultimately supporting safer and more efficient maritime operations in increasingly dynamic and complex maritime traffic environments. This research provides a synthesis of all the different definitions of the MTC, and the paper conclusively gives what should be the most appropriate contemporary definition of this term.

*Keywords: maritime traffic complexity; maritime traffic density; safety of navigation; methodology; review*

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## **(52) UNCERTAINTIES IN FORECASTING GLOBAL AND LOCAL EMISSIONS IN PORTS: RELEVANT PARAMETERS AND VALIDATION APPROACHES**

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### **Abstract**

Maritime terminals design and operation include strategic decisions, involving the engagement of relevant resources and consequent environmental effects, e.g., in terms of global and local emissions. This paper focuses on the research carried out in the framework of the collaborative project (Sapienza University of Rome, University of Catania, University of Ljubljana) on the Design of Maritime Sustainable Terminals (DEMASTER). Starting with an extensive survey covering over 400 port terminals, the achievements focused on key design and operation criteria of sustainability for terminals with 1) various dimensions; 2) different typologies of units and goods; 3) various levels of automation; 4) different operational rules and human behaviors. The research steps were: A) selection of environmental parameters available from public sources; B) data consistency and reliability analysis; C) search of correlation of gaseous emission parameters with dimensions, equipment and traffic; D) selection of reliable correlations; E) use of correlations to forecast emissions to derive dimension and equipment compatible with a certain level of emissions or operational performances. The uncertainties detected in gaseous emission data with reference to container, cruise and Ro-Ro traffic required a deep analysis and a validation for a selection of ports within the Adriatic region, as well as the identification of potential effects of these uncertainties on design and operational parameters.

*Keywords: Ports, Environment, Emissions, Design, Operation*

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## **(53) COMPARATIVE ANALYSIS OF SELECTED OUTCOMES OF THE CENTRAL COORDINATING COMMITTEE'S ACTIVITIES FOR THE SURVEILLANCE AND PROTECTION OF CROATIA'S MARITIME RIGHTS AND INTERESTS**

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### **Abstract**

This paper relies on the analysis and comparison of data from the Annual Reports on the Implementation of Established Policies, Plans, and Regulations concerning the surveillance and protection of the rights and interests of the Republic of Croatia at sea for the period 2022–2024. The annual reports used are publicly available and pertain to the Central Coordinating Committee for Surveillance and Protection of the Maritime Rights and Interests of the Republic Croatia at Sea. Data for 2022 and 2023 were processed by the Ministry of the Sea, Transport, and Infrastructure, while data for 2024 were processed by the Ministry of the Interior, which held the lead coordinating authority in the respective weeks of the year. The study focuses on a comparative analysis and evaluation of the key activities of the Central Coordinating Committee. These include the surveillance of vessels and entities, the inspection of persons on monitored vessels, and the issuance of misdemeanor orders. The results of these activities are assessed in relation to resource allocation, including the number of vessels involved, allocated nautical miles, and fuel consumption by all state bodies participating in the Central Coordinating Committee. The methodology employs quantitative analysis of official data, a comparative interpretation of indicators across the three years, and an assessment of the effectiveness and synergistic impact of the joint actions carried out by all relevant state administrative bodies within the Central Coordinating Committee. The goal of this research is to systematically evaluate the effectiveness of intersectoral collaboration within the framework of the Central Coordinating Committee and to identify potential pathways for enhancing operational efficiency in protecting the rights and interests of the Republic of Croatia at sea.

*Keywords: Central Coordinating Committee, vessel supervision, control, maritime safety, comparative analysis.*

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# **(54) THE ENHANCEMENT OF MARITIME CONNECTIVITY OF SELECTED COUNTRIES IN ASEAN: CASE STUDY OF CAMBODIA, VIETNAM, AND THAILAND**

**Chackrit Duangphastra**

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## **Abstract**

Maritime transportation is generally acknowledged as the most important transportation modes for the international and intra-regional trade of the Association of Southeast Asian Nations (ASEAN). ASEAN countries have attempted to drive the maritime transport as a key instrument to integrate regional economic community and established the roadmap containing a series of plans and measures to improve port facilities, navigation aids, search and rescue cooperation, port accessibilities, unify shipping market, introduce smart and green port development, initializing digital technologies, reduce impact of the rise of ocean freight rates, and develop maritime connectivity among ports in ASEAN and key overseas market. Maritime connectivity is as a priority of regional organisations and regional economic blocks as it is critical to the achievement of sustainable development of international economies. The maritime connectivity can be referred to the performance of shipping transport networks and how well a country or a port is connected to the global shipping network. Better connectivity implies greater access to physical resources and paves the way for economies of scale and specialization by permitting producers to better exploit possibilities in domestic and foreign markets. Then, the improved maritime connectivity plays an essential role in international trade and economic development. This paper aims at examining current status and challenges for developing maritime connectivity mainly on regular containerised cargoes carriage services of selected ASEAN countries including Cambodia, Vietnam, and Thailand. The study will propose recommendations for enhancing the maritime connectivity of individual country and sub-region of ASEAN including initiatives related to the improvement of infrastructure, facilities, technologies and regulatory regime which are responsible by government agencies as well as listing factors affecting the regional development of maritime liner connectivity including volume of cargo throughput, the physical conditions of port and water channel, the efficacy and quality of cargo handling system, port tariffs and charges being collected from ship owners and shippers, congestion at the ports and surrounding areas, port management capability, multimodal transport connectivity system between port and hinterland, availability and efficiency of feeder services linking between primary ports and secondary ports, and the incentives granted by terminal operators to regular shipping lines, and business competitive position of selected port against other neighbouring ports.

*Keywords: Maritime Connectivity; ASEAN; Intra-Regional Trade; Regional Economic Block*

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## **(55) PERSPECTIVES ON MODAL TRANSPORT CHANGE TO MORE SUSTAINABLE METHODS**

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### **Abstract**

Transportation is among the main contributors to climate change impacts. Changing to means of transportation with low ecological footprint has been identified as one of the most viable options in reducing climate change impact of our commuting and in fostering our progress towards sustainable transportation. This study on potential climate change impact of commuting to and from a post secondary institution in Canada was conducted to, among other things, identify how stakeholders travel to the university, reasons for their choice of transportation mode, and factors that would make them change to more sustainable means of commuting. A combination of survey, interviews and observation methods were the methodology used for the study. Results of the study showed our long icy cold winter, availability of limited number of direct transit to the university from where most of the stakeholders reside, long wait time at bus stops for public transit, and limited bike pathways as the reasons for the majority's preference for personal cars. Survey respondents indicated willingness to change to riding public transit if more frequent and direct bus transit as well as heated bus stops are provided. The study showed that adoption of more sustainable means of transportation is attainable with governmental buying in and prioritization.

*Keywords: Commuting, Climate change, Ecological footprint, Sustainable transportation*

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# **(56) MULTIMODAL COMMUTING CHOICES BY MEMBERS OF A CANADIAN UNIVERSITY COMMUNITY: OBSERVATIONS, ANALYSIS AND IMPLICATIONS**

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## **Abstract**

Sustainable transportation has to do with choosing more environmentally friendly means of commuting and moving goods and services from one location to another, with the aim of reducing the amount of greenhouse gas emission released to the environment. Among the popular sustainable commuting methods are walking, biking, carpooling and use of public transit. This study, using a survey method, evaluated the commuting methods among members of a Canadian university and reasons for their choices. Results showed that members of the community use various combinations of transportation methods for various reasons. Among the observed combinations of commuting methods used by the university community are “walking and public transit”, “walking and carpooling”, “biking and public transit”, “carpooling and public transit”, and “driving and public transit”. The majority of those that use multimodal commuting methods are those that commute long distances to and from the university, especially those that are resident outside the university town. Among the reasons for adopting the combination approaches are costs, convenience, limited options, climatic conditions, and family relationship. Results showed that 67% of multimodal users rely on walking and public transit and 32% of those that are using multimodal commuting methods do so for economic reasons. Outcomes of the study would be found useful by faculty, staff and students of a HEI in selecting the location of their residencies in relation to the distance to the university. It would also be found helpful for them in doing cost comparison and convenience of the commuting options that are available to them. Furthermore, it could be found useful by HEI policy makers, HEI planners, and university management in making housing and transportation infrastructure investment decisions.

*Keywords: Environment; Greenhouse gas emissions; Higher Institution of Learning; Mixed modal commuting; Sustainable transport*

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## **(57) EXPERIMENTAL METHOD PROPOSAL FOR ASSESSING THE IMPACT OF OPERATIONAL STRESSORS ON TRAIN DRIVER**

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*<sup>b</sup>Metrans Adria, Ankaranska c. 7b, Koper, Slovenia*

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### **Abstract**

This study proposes an experimental methodology to systematically assess the impact of operational stressors on train drivers' situational awareness and physiological responses during simulated rail operations. It outlines a controlled experimental protocol incorporating representative operational challenges. Physiological measurements will be taken using the Senstream research ring for autonomic signals and iMotions facial expression analysis, enabling continuous monitoring of train driver effort, arousal, and engagement. The design specifies standardized simulation scenarios that replicate realistic train control panel risk factors while ensuring repeatability and precise temporal alignment of multimodal data streams. The primary objective is to establish a methodological framework for quantifying the relationship between environmental disturbances and psychophysiological markers of attention and situational awareness. The resulting protocol is intended to support future empirical studies, facilitate post hoc and real-time workload assessment, and provide a foundation for developing predictive models and adaptive safety and training systems.

*Keywords: Train driver; Electrodermal activity; situational awareness; Facial expressions.*

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## **(58) EMPLOYMENT POTENTIAL OF YOUNG PEOPLE IN THE RAILWAY SECTOR: INSIGHTS FROM BORDER REGIONS**

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### **Abstract**

The railway sector in the EU including Slovenia's cross-border regions faces operational challenges due to shortage of staff with necessary language skills. As a result, customized communication tools are being developed to improve operational communication during cross-border train procedures. This paper analyses the importance of such tools from an employment perspective in rail transport. The study develops railway employment attractiveness approach (REAA) as an analytical framework covering three dimensions (financial, working conditions and competencies) to analyze the willingness of young people to work in the railway sector, as well as recruitment and retention approaches for professions requiring a certain level of foreign language competence. A survey was carried out among 214 secondary school and university students in the Slovenian cross-border area with Italy. Findings indicate moderate interest in railway employment accompanied by high salary expectations. Weekend work and shift work are identified as additional limiting factors further reducing the overall attractiveness of railway jobs. Regarding language skills only 34% of respondents met the required B1 level of Italian. However, 58% non-proficient respondents expressed willingness to learn; a finding confirmed as statistically significant ( $\chi^2=34.67$ ,  $p<0.001$ ). This suggests that language functions primarily as an institutional rather than motivational barrier. By analyzing three fields under REAA, the applicability of specialized structured digital language tools (SDLT) such as T4RAIL has been evaluated. These tools aim to enable professional communication between employees with limited foreign language knowledge. Based on the attitudinal evidence presented in findings, such tools may help mitigate linguistic barriers when recruiting new employees in the railway sector without compromising safety standards.

*Keywords: railway traffic; railway operations; cross-border employment; multilingual communication; translation tools; T4RAIL*

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# **(60) AI-ENHANCED OPTIMIZATION OF PUBLIC TRANSPORT SERVICE SCHEDULING AND STOP LOCATIONS: A LITERATURE REVIEW**

**Tiziana Campisi<sup>a</sup>, Chiara Spadaro<sup>a</sup>, Antonio Russo<sup>a</sup>, Nurten Akgün<sup>b</sup>**

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## **Abstract**

The transportation sector is characterized by significant technological evolution. Public transportation is undergoing a rapid transformation toward sustainability, digitalization, and customization, focusing on the electrification of fleets (electric/hybrid buses), the use of Artificial Intelligence (AI) to optimise flows, and contactless payment systems. The sector is evolving towards on-demand and integrated solutions such as Demand Responsive Transport (DRT) and shared mobility to meet modern needs.

Within this framework, this research proposes a systematic review of the scientific literature, conducted using major academic databases. The analysis is based on a Boolean search strategy that combines specific keywords and considers contributions published over the past two decades. The focus is on bus service scheduling and stop location optimization.

The main aim of this paper is to identify key trends in literature according to model type optimization objectives, stakeholder perspective and highlight the growing role of AI approaches in public transport planning. The results of this preliminary analysis contribute to expanding the knowledge base on advanced tools for optimizing public transport and allow us to identify a set of best practices to support the decisions of service operators and public administrations, both in terms of improving service performance and through the integration of complementary systems and technologies.

*Keywords: Artificial Intelligence; optimisation; bus stop locations; service scheduling*

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# **(61) ENVIRONMENTAL CONTAMINATION AND SURFACE TEXTURE EFFECTS ON RUBBER-STEEL FRICTION: EXPERIMENTAL INSIGHTS FROM LEAF-POLLUTED INTERFACES**

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## **Abstract**

This study investigates friction behaviour and stability in tyre–rail rubber–steel contact under leaf contamination. Four steel surface textures (two isotropic shot-peened and two engineered grooved surfaces) were tested under four controlled leaf hydration states ranging from dry debris to periodically water-sprayed conditions. Friction measurements were performed using a pad-on-disc tribometer under transport-representative loading. Results reveal three distinct regimes. Dry contamination produced stable friction with mean CoF values between 0.55 and 0.80 depending on texture. Fully hydrated leaves generated a friction amplification regime, with peak CoF values exceeding 1.2 on grooved surfaces due to organic film formation and debris compaction. In contrast, periodic water spraying induced a lubricated regime with CoF decreasing to 0.30–0.45 and reduced stability. Statistical analyses confirmed a significant interaction between contamination state and surface texture. These findings demonstrate that moisture level and surface engineering jointly control traction reliability in tyre–rail systems and must be considered in safety-oriented design.

*Keywords: Tire-rail contact; Leaf contamination; Surface texture; Friction stability analysis;*

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# **(62) CLIMATE CHANGE AND SUSTAINABLE FUTURE OF TRANSPORT IN THE WORLD CONTEXT AND EXPERIENCE OF SERBIA**

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Serbia*

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## **Abstract**

Ever since 1941, the largest number of passengers in our country was transported not by buses or trains, but by boats on the Sava and Danube rivers. Crowded ships slowly but surely transported them. Today, things are different. For the first time, the sea passage that connects the Pacific with the Atlantic, along the coasts of Siberia and Norway, is becoming passable 365 days a year due to climate change. Even before the opening of the winter Arctic Sea route, the Northern Sea Route has recorded an increase in shipping traffic. By comparing changes in sea ice levels, researchers discovered that the reduction of sea ice is mainly the result of pollution that contributes to global warming. Climate change is gaining momentum and is on its way to transforming life on Earth. Europe is warming faster than other continents and heat waves are becoming stronger and more frequent. A slowdown in the main ocean current in the Atlantic may also contribute to heat waves in Europe. Like countries in the region, Serbia is and will be affected by climate change, the effects of which are strong (snow in April, more than 20°C in December, heavy floods). At the proposal of the Republic of Serbia, the UN has recently adopted a Resolution on sustainable development of the planet, which will be implemented from 2024 to 2033. It is a platform for the cooperation of all relevant actors, in order to promote science as the key to achieving a sustainable future. The aim of this paper is to contribute to raising awareness of the seriousness of the international problem of climate change and finding a solution in order to provide a sustainable future for transport. It is important to stay connected and not forget the flood wave from Slovenia that raised water levels of the Sava and Danube rivers and flooded the Čukarički creek. However, water reserves in Europe are decreasing due to climate change. Cooperation and the exchange of experience in this common struggle are fundamental. In 2025, the European Parliament approved a new Soil Health Monitoring Act, the first of its kind at the European Union level, because estimates show that as much as 60-70% of Europe's soil is contaminated. Soil degradation in Europe represents, a wake-up call for the entire continent.

*Keywords: climate change; pollution; world; Serbia; cooperation*

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## **(63) MODAL SHIFT FEASIBILITY FOR USING E-BIKES FOR HOME-TO-WORK COMMUTING IN THE MARIBOR FUNCTIONAL URBAN AREA**

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### **Abstract**

This paper examines the potential for reducing car-based commuting through an employer-led e-bike pilot implemented within the Interreg Central Europe project GreenPATH. As part of the pilot, 10 employees and post-doctoral students of the Department of Transportation Engineering at the University of Maribor who commuted to work mostly by car were provided e-bikes for home-to-work commuting. A mobility profiling survey was used to identify pilot candidates: out of 90 responses, 10 participants were screened and selected based on their current home-to-work transport mode, stated motivation for e-bike adoption, and willingness for modal shift from car to e-bike. Preliminary pilot results indicate an observed modal shift from car to e-bike with adoption and sustained use influenced by trip length, user motivation and the availability and safety of cycling network. Secure workplace facilities for storage, changing, and e-bike charging were also identified as crucial factors. Participants additionally reported higher commute satisfaction, increased physical activity, and fuel and parking cost savings. These findings offer actionable insights for replicating employer-led e-bike commuting schemes across the Maribor Functional Urban Area.

*Keywords: Home-to-work commuting; e-bike adoption; mobility profiling survey; modal shift*

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## **(64) INTEGRATED SUSTAINABILITY ASSESSMENT FRAMEWORK FOR CRUISE PORTS**

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### **Abstract**

Over the past several decades, cruise tourism has grown rapidly, but this growth has increased the environmental, geographical, and socioeconomic constraints on ports and coastal cities. Cruise ships produce enormous amounts of solid and hazardous waste and wastewater, contribute to greenhouse gas emissions (CO<sub>2</sub>), nitrogen oxides (NO<sub>x</sub>), sulfur oxides (SO<sub>x</sub>), and particulate matter (PM), increase noise levels in the air and underwater, and impose more strain on local infrastructure. This article presents the Cruise Port Audit Scheme (CPAS), a port-level sustainability framework based on the Plan-Do-Check-Act (PDCA) cycle. The comprehensive study summarizes the main effects, the relevant EU regulatory environment, the CPAS framework, and useful suggestions for controlling emissions, noise, waste and water, shore excursions, infrastructure, and community relations.

*Keywords: cruise tourism; port sustainability; environmental impact; PDCA cycle; renewable energy*

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## **(65) REVIEW OF NEW TECHNOLOGIES AND AUTONOMOUS SYSTEMS ON MODERN OFFSHORE VESSELS**

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### **Abstract**

Modern offshore vessels face increasing operational challenges as projects move into deeper waters and harsher environments. Technologies such as active heave compensated cranes, motion-compensated gangways, dynamic positioning (DP) systems, modern launch and recovery systems (LARS), and autonomous or semi-autonomous marine vehicles have significantly improved both efficiency and safety. This paper provides a structured review of these technologies and their recent developments, explaining how they transform vessel operations to enable safer subsea construction, maintenance, and transport while reducing operational risks. Digital monitoring tools and integrated control platforms further enhance decision-making through real-time supervision of propulsion, power management, and deck machinery. The combination of modern hardware and software reflects a gradual shift toward higher automation, smarter operational planning, and lower environmental impact.

*Keywords: offshore vessels, modern equipment, dynamic positioning, heave compensation, LARS, vessel safety*

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# (66) MARITIME SEARCH AND RESCUE IN THE REPUBLIC OF CROATIA: AN ANALYSIS OF INCIDENT PATTERNS AND OPERATIONAL TRENDS

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## **Abstract**

This study aims to analyse maritime Search and Rescue (SAR) interventions in Croatia between 2018 and 2024 in order to identify key incident patterns and operational trends. Based on official reports from the Maritime Rescue Coordination Centre Rijeka, a total of 4046 SAR interventions were recorded during this period. Medical interventions increased by 139%, now accounting for nearly three-quarters of all operations. Linear regression revealed highly significant declines in false alarms ( $\beta = -18.6$ ,  $p = 0.001$ ;  $-83.6\%$ ) and vessels unfit for navigation ( $\beta = -9.9$ ,  $p = 0.002$ ;  $-85.5\%$ ). Motor yacht charter registrations showed a decreasing but non-significant trend ( $\beta = -105.9$ ,  $p = 0.38$ ;  $r^2 = 0.57$ ), with an overall decline of 74.7% from 2018 to 2024. Foreign vessel arrivals increased moderately from 2020 to 2023 (32.9%), while boat extensions rose by 7.8% between 2021 and 2023. A very weak correlation was observed between nautical traffic intensity and medical interventions ( $r = 0.07$ ,  $p = 0.88$ ), and a weak negative correlation between motor yacht registrations and medical interventions ( $r = -0.27$ ,  $p = 0.56$ ). Enhanced coordination with emergency medical services, targeted safety education, and adoption of new technologies are recommended to maintain effective protection of human life at sea. The findings may assist maritime safety authorities and SAR planners in optimising resource allocation and developing targeted prevention measures.

*Keywords: maritime search and rescue; SAR system; maritime incidents; recreational boating; operational analysis; Adriatic Sea*

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## (68) TECHNICAL AND ORGANIZATIONAL CONSTRAINTS IN INTEGRATING S-102 AND S-101 WITHIN THE S-100 FRAMEWORK

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### Abstract

Modern navigation systems rely on reliable and interoperable data standards to support decision-making in maritime operations. The S-100 framework, developed by the International Hydrographic Organization, is being introduced through a phased transition from S-57. Within this framework, S-101 Electronic Navigational Charts and S-102 high-resolution bathymetric surfaces are anticipated to become key components of advanced ECDIS capabilities, enabling improved depth awareness, under-keel clearance management, and enhanced navigational decision-support. Although S-100-capable systems have been demonstrated, the operational integration of S-102 with S-101 products remains limited for broad deployment. The main problem addressed in this paper is the constrained integration of S-102 bathymetric data into ECDIS, driven by a combination of technical, organizational, and governance factors. We show that these barriers arise not only from engineering challenges (e.g., performance variability, portrayal inconsistencies, and heterogeneous production and validation workflows) but also from enabling conditions related to governance, coordination, and operational testing across stakeholders. In contrast to earlier assessments that treated S-102 implementation primarily as a software engineering issue, our findings indicate that institutional and governance-related constraints can act as obstacles of comparable significance. While the transition appears achievable in principle, realizing the operational potential of S-101/S-102 integration will require continued specification refinement, coordinated testing, and sustained governance mechanisms that support consistent multi-product use.

*Keywords: S-100; S-102; ECDIS; Bathymetry; Data integration*

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# **(70) MARITIME ACCIDENTS ALONG THE EASTERN ADRIATIC COAST: CORRELATIONS WITH TRAFFIC INTENSITY AND SEA AREA SIZE**

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## **Abstract**

The eastern coast of the Adriatic Sea features a highly indented shoreline and substantial maritime traffic, especially during the summer months when the number of vessels of all categories increases significantly. Under these conditions, the frequency of maritime accidents also rises, providing a statistically relevant dataset for examining risk factors and modelling the probability of accident occurrence. This work presents a detailed analysis of the spatial distribution of maritime accidents along the eastern Adriatic coast and compares these findings with traffic data across administratively defined maritime zones of the Republic of Croatia. The methodological approach includes geographic spatial modelling, statistical comparison of traffic intensity and accident incidence, and identification of areas with the highest concentration of accidents. Special attention is given to differences in the frequency of individual categories of accidents, primarily collisions and groundings, in relation to the characteristics of the sea area in which they occur, including traffic density, coastal morphology, and seasonal variations. The analysis is based on official statistical data from search and rescue operations conducted by the harbour master's offices of the Republic of Croatia, covering all types of vessels, from small recreational craft to larger commercial ships. The results should contribute to a deeper understanding of risk factors in the Croatian part of the Adriatic and may serve as a foundation for enhancing maritime safety measures and optimizing surveillance and preventive activities.

*Keywords: Eastern Adriatic Coast, Maritime accidents, traffic intensity, collisions and groundings*

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## **(71) THE ROLE OF PASSENGER SHIP CREW IN THE PERFORMANCE OF MARITIME PASSENGER TRANSPORT CONTRACTS**

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### **Abstract**

The performance of a maritime passenger transport contract, particularly on cruise ships and ferries, encompasses far more than the mere act of transferring passengers from the port of departure to the port of destination. It involves a wide range of operational and organizational processes. Achieving passenger satisfaction, an essential indicator of successful contract execution, requires that the service be delivered without disruptions. Within this complex framework, the role of the ship's crew is crucial. Their work spans diverse operational, safety related, and service oriented tasks, raising important questions about how the ship's crew perceive their own role, responsibilities, and overall contribution to the fulfilment of passenger transport contracts. The main objective of the paper is to identify and analyze the roles and responsibilities of the ship's crew in the performance of maritime passenger transport contracts, as well as to explore how they perceive these obligations. By examining the collected attitudes and experiences of ship's crew regarding their roles and responsibilities in performing the contract, this study examines how working conditions, communication and collaboration within the crew, and the availability of resources influence the successful execution of maritime passenger transport. Alongside an overview of the fundamental legal and contractual characteristics of passenger transport by sea, the paper includes a survey conducted on a randomly selected sample of seafarers. The findings provide valuable insights into the practical role of ship's crew and highlight the challenges they face in carrying out their contractual duties. The research applies standard scientific methods, including description, analysis, and synthesis.

*Keywords: Passenger transport by sea; ship's crew; contract performance; maritime operations; ship's crew' perceptions*

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# **(73) ANALYSIS OF LEGAL SOURCES IN THE FUNCTION OF PREVENTING POLLUTION OF THE MARINE ENVIRONMENT FROM VESSELS**

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## **Abstract**

Insufficient awareness of the consequences of human activities continues to contribute to pollution of the marine environment. By adopting international conventions, efforts have been made to harmonize rules and standards for its protection. Signatory states have aligned their national legislation with these instruments and are taking steps to ensure their effective implementation. At the same time, the European Union is adopting directives and other legal acts that provide additional protection for the marine environment within its borders and promote awareness of its preservation. Given the above, the aim of this scientific paper is to assess the effectiveness of the existing legal framework for marine environment protection and propose measures for its improvement. The authors place particular emphasis on environmental impact assessment as a key instrument for achieving the highest possible level of environmental protection and minimizing adverse effects. All participants in maritime transport should be subject to international conventions in order to reduce negative impacts on the marine environment to the lowest possible level.

*Keywords: pollution; international conventions; European Directives; national regulations*

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## **(74) DEVELOPING AN AI MATURITY MODEL: INSIGHTS FROM FREIGHT FORWARDERS**

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Prinsstraat 13, Antwerp 2000, Belgium*

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### **Abstract**

Managers in port and logistics operations face significant challenges in selecting and implementing appropriate artificial intelligence (AI) tools. One key barrier is the lack of insight into their organisation's readiness for AI adoption. This paper presents a dedicated maturity framework specifically designed for the freight forwarding sector, addressing the gap in systematically assessing organisational maturity and guiding structured AI implementation. First, a comprehensive review of academic literature was conducted, focusing on AI maturity, model comparisons, and freight forwarding tasks. Based on this conceptual framework, a detailed multiple-choice questionnaire with clarifying answers and examples was constructed to identify maturity levels and growth areas. After validation and feedback from a business perspective, the model was completed by 21 representatives of freight forwarders.

The results show that most companies are currently at the “Active” maturity level: they show interest in AI and have initiated pilot applications, but structured, organisation-wide implementation is often lacking. A few companies reached the “Operational” level, while the higher levels “Systemic” and “Transformational”, were not attained. Overall maturity was comparable of forwarders active in Antwerp and in Rotterdam, although differences emerged at the dimension level. Larger companies, based on employee numbers, scored slightly higher in certain AI domains.

*Keywords: AI maturity; freight forwarders; growth areas; benchmarking*

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## **(75) EDUCATIONAL CHALLENGES IN TRAINING AUTONOMOUS SHIP OPERATORS**

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### **Abstract**

The education of autonomous ship operators represents one of the challenges in the implementation of maritime autonomy. Unlike conventional vessels, where humans directly control navigation operations, autonomous ships rely on supervisory control, remote operation, and decision-making in exceptional situations. The transformation of operational roles, lack of standardization training, interdisciplinary competence requirements, psychological factors, cognitive focus, and rapid technological development demand a fundamentally new educational program.

The paper analyses possible solutions for implementing an educational program for autonomous ship operators, taking into account their age, experience, role on standard vessel and current level of maritime standard education.

*Keywords: education of autonomous ship operators; simulator training; autonomous vessels*

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## **(76) MULTI-CRITERIA EVALUATION OF WAYS TO OVERCOME CHALLENGES IN PHARMACEUTICAL SUPPLY CHAINS**

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### **Abstract**

Modern pharmaceutical supply chains face complex challenges such as supply instability, inaccurate forecasting and limited transparency. This paper identifies and analyzes the key challenges in pharmaceutical supply chains and then presents innovative technologies and approaches that can be employed to overcome these issues and enhance system efficiency and resilience. Using the AHP (analytic hierarchy process) and ADAM (approach of decision-making assessment model) methods, a multi-criteria evaluation was conducted to identify alternatives with the highest potential for improving supply chain performance. The results indicate that Data Analytics and Predictive Modeling play a dominant role in addressing the identified challenges, while technologies such as IoT and Blockchain further strengthen traceability, security, and coordination. These findings offer a strategic framework for managers to prioritize digital investments and improve overall PSC performance.

*Keywords: pharmaceutical supply chains; challenges; innovative technologies and concepts; AHP; ADAM; multi-criteria decision making*

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## (77) ANALYSIS OF INFLUENCES ON COMMUNICATION IN THE ENGINE ROOM

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### **Abstract**

The successful execution of everyday tasks in a ship's engine room – and sometimes even the safety of the ship itself – depends largely on effective communication. Communication in a ship's engine room is influenced by various factors and circumstances, such as noise, hearing protection, language barriers, and the knowledge and skills of the participants involved. Although the importance of these aspects is well known and recognized, few scientific articles have addressed this issue. This article presents the initial phase of a study undertaken to determine the influence of various factors on communication in the engine room. In addition to presenting the problem, the article outlines the preliminary stage of the research. The preliminary stage served to create a research plan, formulate phrases and messages to be communicated, and test these using small test groups. Given that the problem outlined concerns communication in the ship's engine room, the content being communicated consists of marine engineering terms. The first test group consisted of marine engineering students familiar with the terminology, and the second group consisted of electrical engineering students unfamiliar with it. All tests were conducted in a quiet environment. The first step involved the transmission of everyday words and messages, and the second step the transmission of messages containing professional marine engineering terminology. The third and fourth steps repeated the first two, except that the phrases were in English. Both groups of students had a relatively good knowledge of English and completed the same process. Preliminary tests showed that the research plan was viable and that the measurement results obtained were as expected.

*Keywords: Engine room, communication, noise, hearing protection, foreign language.*

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## (78) ACCESSIBLE BARRIER-FREE INCLUSIVE CROSS-BORDER PUBLIC TRANSPORT SUMMER SCHOOL

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### **Abstract**

Ensuring accessible, barrier-free, and inclusive public transport systems is fundamental to social participation, equal opportunities, and sustainable urban and regional development. While technical standards and legal frameworks provide important foundations, truly barrier-free transport requires professionals who understand accessibility not only as a regulatory obligation, but as a societal responsibility and a core design principle. Against this background, the EPTS-HG Summer School, a unique programme set up by the Austrian Association in support of the Blind and Visually Impaired (HG) and the European Platform for Transport Sciences (EPTS), offers an innovative educational format dedicated to accessible, barrier-free, and inclusive cross-border public transport.

This article presents the conceptual foundations, pedagogical approach, and first experiences of the summer school. Particular attention is given to its experiential learning model, the interdisciplinary composition of participants, and the role of lecturers and practitioners in shaping a transformative learning environment. By analyzing the Summer School's educational design and observed outcomes, the paper highlights how higher education can actively contribute to advancing inclusive mobility in research, planning, and practice.

*Keywords: summer school; accessible; barrier-free; inclusive; cross-border public transport; education*

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# **(80) ASSESSING HUMAN AND SYSTEM RISKS IN REMOTE OPERATIONS CENTRES FOR MARITIME AUTONOMOUS SURFACE SHIPS**

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## **Abstract**

The development of maritime autonomous surface ships (MASS) presents new opportunities for safer and more efficient maritime operations, but also fundamentally reshapes the role of humans in remote operations centres (ROCs). Rather than serving as auxiliary IT support, ROCs are increasingly recognised as functional extensions of the ship's bridge or engine room, where remote operators assume operational responsibilities comparable to those of onboard watchkeepers. In a hybrid environment where autonomous and conventional vessels operate side by side, communication limitations such as data delays, interruptions, limited system transparency, and mismatches between formal procedures and actual practice pose significant risks to situational awareness and timely intervention. Based on a literature review and analysis of selected maritime accidents involving VTS and autonomous vessels, this paper examines how the limitations affect human-in-the-loop performance. The findings indicate that MASS safety depends not only on technological sophistication but primarily on effective human–system cooperation, including clear authority structures, transparent automation, and manageable cognitive workload. The paper concludes with practical recommendations for communication protocols, human–machine interface (HMI) design, and the development of operator competencies necessary for the safe and reliable integration of MASS into maritime transport.

*Keywords: MASS; ROC; remote operators; situational awareness; human-in-the-loop*

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# **(81) A COMPOSITE INTEGRATION SCORE APPROACH FOR EVALUATING DEMAND RESPONSIVE TRANSPORT IN ENNA: SENSITIVITY ANALYSIS AND AHP PERSPECTIVES**

**Tiziana Campisi<sup>a</sup>, Chiara Spadaro<sup>a</sup>, Aicha Tijany<sup>a</sup>, Giovanni Tesoriere<sup>a</sup>,  
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## **Abstract**

The analysis of contemporary transport supply and demand must account for changing travel behaviours, increasing socio-demographic diversification, and the growing prevalence of low-demand areas. These trends are driven by transformations in working patterns, the diffusion of new transport modes, population ageing, income dynamics, and the depopulation of certain territories. The integration of Demand Responsive Transport (DRT) with conventional public transport (PT) offers significant potential for improving mobility in low-demand and topographically constrained contexts. This study proposes a scoring-map methodology to support the planning and spatial design of integrated DRT–PT services, with a specific application to the city of Enna (Italy). The proposed framework combines multidimensional indicators—including population density, accessibility to essential services, distance from public transport routes, slope and geographical constraints, and the presence of vulnerable users—each weighed according to its contribution to mobility needs. The indicators are normalised, aggregated, and spatially mapped to identify priority areas where DRT can effectively complement the existing public transport supply. Decision rules are defined to classify areas into high-, medium-, and low-priority service zones, accounting for Enna’s distinctive urban morphology, steep terrain, and dispersed residential patterns. The results show that scoring maps can effectively identify underserved areas, reveal spatial inequalities, and guide the design of flexible transport solutions that enhance service coverage and equity. Overall, the proposed methodology provides a replicable, evidence-based tool to support transport authorities in integrating DRT within complex urban and peri-urban environments.

*Keywords: Integrated transport system PT-DRT; scoring map; transport priority*

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# **(82) BRIDGING OPERATIONAL PERFORMANCE AND POLICY OBJECTIVES IN PT–DRT SYSTEMS: A MULTI-LEVEL KPI FRAMEWORK FOR INTEGRATED MOBILITY EVALUATION**

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## **Abstract**

The increasing demand for flexible and more efficient mobility systems necessitates advanced instruments for monitoring and evaluating public transport performance. In particular, the integration of conventional public transport (PT) with Demand Responsive Transport (DRT) services is among the most promising strategies for improving efficiency, territorial coverage, and overall service quality within multimodal mobility networks. This study conducts a systematic review of scientific literature with the aim of identifying, classifying, and evaluating the key performance indicators (KPIs) used to measure the level of integration between the two service types. The analysis considers both academic contributions and real-world applications, highlighting metrics that fall into three main categories: operational performance (e.g., punctuality, waiting time, vehicle occupancy rate, trip efficiency), user performance (e.g., accessibility, user satisfaction, reduction of door-to-door travel time, ease of tariff and information integration), and system performance (e.g., reduction in vehicle-kilometres, economic sustainability, environmental impact, and overall increase in public transport demand). The results indicate a growing methodological convergence in the definition of KPIs, while also revealing the need for more standardised indicators to evaluate complex scenarios of multimodal integration. This study offers a solid theoretical foundation for public authorities, operators, and researchers involved in the design and assessment of innovative integrated mobility models.

*Keywords: KPIs; public transport and DRT integration; bus stops*

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## **(83) PROACTIVE METHOD FOR ROAD NETWORK SAFETY ASSESSMENT: A COMPREHENSIVE ANALYSIS**

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### **Abstract**

The road infrastructure safety assessment via a proactive method reveals an entirely new dimension in traffic safety analysis. Its positive impact is seen as a milestone for road traffic safety management projects, and it has undoubtedly become a part of national road traffic safety strategies and programs. The Republic of North Macedonia has seen an acceleration in terms of investments in the construction of new road sections and modernization, the introduction of intelligent transport systems (ITS), and measures for green transition (challenges of the triple transition: socio-economic, green, and digital). These activities are part of the national strategic priorities for the development of modern and sustainable transport infrastructure in order to improve safety, efficiency, and connectivity with neighbouring countries. The paper outlines the process of development and adaptation of a national methodology for road traffic safety assessment based upon a proactive approach, enabling objective monitoring, comparison, and improvement of the state of the system by key safety performance indicators (KPIs), which is a basic prerequisite for efficient traffic safety management. The methodology includes a detailed description of the features of the proactive model and national guidance for monitoring road safety performances using a network-wide approach. To that end, a methodology provides guidance and detailed roadmaps for effective implementation for researchers and practitioners in designing a modern system of traffic safety management for reducing the risk of traffic accidents.

*Keywords: Road Safety Assessment; Proactive Method; Road Network Infrastructure; Key Performance Indicators.*

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## **(85) CORPUS LINGUISTICS METHODS FOR BUILDING TECHNICAL GLOSSARIES: THE EXAMPLE OF A TEXTBOOK ON LOGISTICS**

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### **Abstract**

Mastering technical vocabulary is a central goal for both learners and instructors in English for Specific Purposes. This paper examines corpus linguistics methods for identifying technical vocabulary within a specific professional domain. In particular, we propose an effective methodology for extracting key technical terms and multiword units from a textbook on logistics. The anonymized textbook on professional English for students of logistics was processed to compile a relevant corpus finalized at 37,231 tokens or 2,444 lemmas. Since the textbook includes its own glossary, it was used both as a benchmark for determining the appropriate length of the generated list and as a reference for comparing and evaluating the finalized glossary of approximately 300 items. The resulting glossary includes individual lexical items as well as multiword units, reflecting the collocational and n-gram patterns characteristic of the logistics professional setting. In addition, the results are compared with the textbook glossary in order to assess the advantages and limitations of using lexical analysis tools, such as Sketch Engine, in the compilation of technical glossaries and indexes. The proposed methodology is described in detail to support its replicability for other types of professional corpora.

*Keywords: corpus linguistics; technical vocabulary; lexical analysis; glossary; logistics*

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## **(86) ASSESSMENT OF SELECTING GREEN FUELS IN CROATIAN SEAPORTS**

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### **Abstract**

Transition of maritime transport to green energy fuels is a key goal of the European Green Deal. Ports are critical points in the transport and logistics chain where fuel supply takes place. When planning green ports and the types of alternative green fuels that will supply vessels, it is essential to consider parameters that are crucial for fuel selection. Incorrect fuel choice or inadequately prepared infrastructure can generate significant financial losses, operational disruptions, and regulatory non-compliance.

This paper evaluates the risks associated with the choice of alternative fuels in Croatian ports: Rijeka, Split, Zadar, Šibenik, Ploče, and Dubrovnik, within the context of the Green Corridors for Carbon-Neutral Cruise and Ferry Shipping in the ADRION Region- GREENROUTES.

*Keywords: Alternative fuels, Green Fuels, Alternative Fuels, Risk assessment, Seaports, Decarbonization, Ferries, Infrastructure;*

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## **(87) ANALYSIS OF THE VENTILATION AND AIR CONDITIONING SYSTEM OF A CARGO SHIP, CASE STUDY**

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### **Abstract**

This paper analyses a heating, ventilation, and air conditioning system as part of the cooling system of a Korean-class container ship. The ventilation and cooling system is described in detail, including characteristic devices and associated calculations in accordance with ISO standards. With integrated automation, air handling units and condensing units provide precise control of temperature, humidity, and air quality while complying with global environmental standards. Special attention is given to air exchange requirements, which are essential for crew health and equipment preservation. The Croatian Register of Shipping and the Korean Register of Shipping have similar technical and safety requirements; however, the Croatian Register of Shipping places greater emphasis on energy efficiency, environmental protection, and compliance with EU regulations. After analyzing the technical parameters and reviewing the documentation, it was concluded that a ship built to the standards of the Korean Register of Shipping should meet the requirements of the Croatian Register of Shipping, with possible minor modifications such as replacing coolants or upgrading the filtration system. A comparison of the as-built state and calculations according to the requirements and recommendations of the Croatian Register of Shipping for the analysed systems shows that the derived values exceed the minimum requirements, confirming this conclusion.

*Keywords: HVAC; AHU; CU; Korean Register; Croatian Register of Shipping.*

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## **(88) INFLUENCE OF INPUT PARAMETERS ON THE EFFICIENCY OF A REFRIGERATION PLANT**

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### **Abstract**

This paper presents a system analysis and an experiment conducted on the cooling system of the ET400e. The refrigeration system was analysed using a didactic device at the Faculty of Maritime Studies, designed for student training, which includes all the components of a real system and enables various exercises. The paper provides a technical description of the system and its operating principle. During the experiment, the system's operating efficiency was tested by varying the condenser fan's operating parameters. Adjusting the fan speed affected the airflow through the condenser, thereby altering the heat exchange between the refrigerant and the ambient air. The aim was to observe the system's efficiency and determine the extent to which the fan speed could be reduced while maintaining smooth operation. The results facilitate the selection of the optimum operating mode to extend the system's service life. The data presented provide a solid basis for further investigations, which could involve varying other system parameters, and a solid foundation for applying the same principle in practice to save energy and reduce environmental impact.

*Keywords: Efficiency, ET 400e, Environment, Operating Parameters.*

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# **(89) INTELLIGENT TRANSPORT SYSTEMS AS A DRIVER OF SUSTAINABLE AND ECONOMICALLY EFFICIENT MOBILITY: A CASE STUDY OF THE CITY OF SPLIT**

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## **Abstract**

The article analyses the implementation of intelligent transport systems (ITS) in the traffic sector of the city of Split and their role in improving the safety, flow, and sustainability of urban transport. The ITS project in Split represents an integrated set of solutions that combine adaptive traffic light control, video surveillance, mobile applications for passenger information, variable traffic sign systems, public transport priority, and environmental condition monitoring. These solutions enable real-time data collection and processing, thereby supporting the adoption of more effective transport strategies. The introduction of ITS technologies is expected to reduce congestion, travel times, traffic accidents, and emissions, while increasing the reliability of public transport and user awareness. The project also lays the foundation for more rational resource use, generating significant economic benefits through reduced transport costs, improved mobility management, and increased productivity of the overall transport system. A key value of the project lies in the integration of all subsystems with the Traffic Management Centre, enabling coordinated planning and rapid response in dynamic traffic conditions. The results of the case study indicate that the ITS project in Split represents a major step toward an economically sustainable, modern, and environmentally responsible transport system, contributing significantly to the quality of life of citizens and the city's competitiveness. In this context, ITS are recognised as an important element of the green and digital transformation of cities, whose effectiveness depends on the coordinated cooperation of various stakeholders and a strategic approach to urban transport development.

*Keywords: intelligent transport systems, traffic management, economic impacts, environmental impacts, urban mobility, sustainable development*

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# (91) MASTER’S LIABILITY IN CONTEMPORARY MARITIME CASUALTIES

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## **Abstract**

The legal responsibility of the ship’s Master has historically been framed as absolute, rooted in centuries-old philosophies of navigational sovereignty and command authority. However, contemporary maritime operations are embedded within complex regulatory, technological and corporate governance systems that significantly mediate operational autonomy. This article critically examines the evolving scope of Master’s liability through a domain-based analytical framework distinguishing between autonomous command decisions and system-constrained operational environments. Through comparative analysis of the casualties involving “Wakashio” (2020), “Prestige” (2002) and “Viking Sky” (2019), the study demonstrates that liability attribution in modern maritime law cannot rely solely on individualized fault paradigms. Instead, proportional accountability must reflect degrees of operational autonomy, fundamental constraint and institutional influence. The paper proposes a four-step proportional liability matrix to guide maritime courts, investigators and policymakers. The findings contribute to the broader debate on command responsibility in an era characterized by automation, environmental governance expansion, digital monitoring and increasing criminalization of maritime accidents.

*Keywords: Master’s liability, proportional accountability, maritime governance, operational autonomy, fundamental constraints, ISM Code, maritime criminalisation, port of refuge*

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## (92) CORRELATION BETWEEN NO<sub>x</sub> AND CO<sub>2</sub> EMISSIONS UNDER VARIABLE LOAD CONDITIONS AT CONSTANT SPEED IN FOUR-STROKE DUAL FUEL ENGINES

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### Abstract

This paper examines the correlation between nitrogen oxides (NO<sub>x</sub>) and carbon dioxide (CO<sub>2</sub>) emissions under variable engine load conditions in a four-stroke dual-fuel marine engine operating at constant speed. Actual shipboard measurements of NO<sub>x</sub>, CO<sub>2</sub>, and specific fuel consumption were collected across engine loads from 20% to 90% for three fuel types: liquefied natural gas (LNG), marine diesel oil (MDO), and heavy fuel oil (HFO). The results show a strong linear NO<sub>x</sub>–CO<sub>2</sub> correlation for LNG operation, driven by the stability of lean-burn combustion, whereas MDO and HFO show weaker and more scattered correlations due to the non-uniform thermochemical behaviour of diffusion combustion. The findings provide insight into the load-dependent emission characteristics of dual-fuel engines and underline the importance of fuel type and operating conditions when evaluating compliance with MARPOL Annex VI, the Energy Efficiency Index for Existing Ships (EEXI), and the Carbon Intensity Indicator (CII).

*Keywords:* Dual-Fuel engine emissions; Engine load; NO<sub>x</sub> emission; CO<sub>2</sub> emission; NO<sub>x</sub>–CO<sub>2</sub> correlation.

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# **(93) SEASONAL AND SPATIAL DYNAMICS OF CHLOROPHYLL-A IN THE CENTRAL ADRIATIC: MULTI-INDEX ANALYSIS USING SENTINEL-3 OLCI DATA**

**Anita Gudelj, Merica Slišković, Helena Ukić Boljat, Jelena Čulić Gambiroža**

*University of Split, Faculty of Maritime Studies, 21 000 Split, Croatia*

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## **Abstract**

Coastal marine ecosystems, such as the Adriatic Sea, are highly sensitive to seasonal changes in temperature, salinity and nutrient availability, which is directly reflected in marine productivity levels. Monitoring changes in chlorophyll-a concentration, an important indicator of the presence of phytoplankton and changes in the productivity in the marine environment is a particular challenge since in situ measurements are often limited to smaller local areas and a specific time period. In this context, Satellite remote sensing enables continuous and wide-scale monitoring of the marine environment.

This paper presents an analysis of seasonal changes in the productivity of coastal waters of the central Adriatic using Sentinel-3 OLCI satellite data. The research focuses on the spatial and seasonal variations in chlorophyll-a concentration (CHL) using the Normalized Difference Chlorophyll Index (NDCI) and the Floating Algae Index (FAI). Additionally, an unsupervised machine learning classification based on the K-means clustering was applied to classify marine productivity into low, medium, and high zones. The combination of spectral indices (NDCI, FAI) and unsupervised machine learning classification enables a deeper understanding of the seasonal dynamics of the marine ecosystem. The results indicate higher chlorophyll-a concentrations and marine productivity during winter, especially in estuaries, whereas in summer, they decrease due to thermal stratification and limited nutrient availability. NDCI and FAI indices confirm seasonal fluctuations, while the K-means clustering provides a quantitative basis for tracking productivity changes across seasons. These findings suggest that the combination of satellite indices and machine learning algorithms can serve as a supporting tool for the analysis of spatio-temporal dynamics of marine productivity.

*Keywords: Sentinel-3 OLCI; Chlorophyll-a; NDCI; FAI; K-means clustering; Seasonal variability*

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# **(94) EVALUATION OF THE IMPACT FACTORS ON THE TEMPERATURE OF GOODS IN THE COLD CHAIN LAST MILE DELIVERY**

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## **Abstract**

Maintaining the temperature of vehicle cargo compartment within the prescribed tolerance limits is essential for compliance with quality standards in the last mile delivery of refrigerated products, where frequent opening of the vehicle cargo compartment doors along delivery route causes exposure to outside temperature. In this research, key operational and environmental impact factors on the temperature of goods during transport in frigo regime of +2 °C to +4 °C are evaluated, to optimize the delivery routes in the last mile delivery (LMD) of refrigerated products. The field research was carried out on a MAN TGL 12.220 truck (12 tons payload) equipped with multi-channel temperature sensors and door sensors with continuous monitoring of the outside temperature on the transport route Rugvica (garage) – Zagreb Centre. Preliminary analysis of the empirical data indicates a significant influence of duration of open doors periods (ODP), time between delivery stops, load factor, and outside temperature. Reducing the cargo compartment occupancy (load factor) below 30% significantly accelerates heating due to reduction of thermal inertia of the system. The greatest operational potential for maintaining the cold chain conditions can be achieved by shortening the ODPs duration and planning an itinerary that more sensitive goods are delivered during the phase of higher load factor. In this regard, practical recommendations have been formulated for optimizing delivery routes, improving energy efficiency, and quality of the LMD in the cold chain.

*Keywords: cold chain; last mile delivery; temperature fluctuations; delivery routes optimization*

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## (96) CRUISE SHIP EMISSIONS: A COMPARATIVE ASSESSMENT OF ADRIATIC PORTS

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### **Abstract**

In recent years, concern over the environmental impact of cruise port activities has grown, especially in areas with heavy passenger and tourist traffic. Cruise ships are major contributors to air pollution in coastal zones, as their high energy demand generates emissions comparable to those of small towns. This issue is particularly evident in Adriatic ports, where cruise traffic rises sharply during the tourist season. When moored, ships keep their auxiliary engines running to supply critical systems and on-board services.

Assessing the quantity of these pollutants is essential, yet many ports lack adequate monitoring infrastructure. As a result, emission inventories remain a practical alternative. This paper proposes a methodology based on technical and operational data from cruise ships, with a focus on time spent in port, since their energy requirements are higher than those of other vessel types. The main contribution lies in a bottom-up approach that incorporates detailed port-call profiles and vessel-specific auxiliary-engine load factors, enabling more accurate estimation of hoteling emissions in the absence of direct measurements.

A comparison of Adriatic ports reveals substantial variability in cruise-ship emissions, influenced by infrastructure characteristics, average stopover duration, and annual call numbers. Ports with strong tourist appeal or limited mitigation measures, such as a lack of cold ironing or cleaner fuels, tend to exhibit higher emission levels, affecting air quality in adjacent urban areas.

This analysis offers a valuable contribution to understanding pollution dynamics linked to cruise traffic and provides a solid basis for developing more sustainable port-management strategies in coastal regions.

*Keywords: Port air pollution; Adriatic ports; Port sustainability, Cruise ships*

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# (97) ASSESSING THE SAFETY OF TRAM-TRAINS IN SZEGED: INSIGHTS FROM EYE-TRACKING AND PUBLIC PERCEPTION

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Hungary*

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## **Abstract**

In 2021, Szeged introduced the tram-train, a new type of fixed-rail vehicle previously unknown in Hungary. Its exterior colour scheme differs markedly from that of traditional trams, which have been predominantly painted yellow for more than a century. In 2022, the first full year of operation, tram-trains were involved in road accidents at approximately twice the rate of conventional trams, despite their lower daily service frequency.

Since 2022, accident data show that collisions are significantly more likely to involve tram-train vehicles than conventional trams. These accidents were analysed using in-depth investigations and collision diagrams, and infrastructure-related measures were proposed. To further investigate human-related factors, a questionnaire survey was conducted among drivers in Szeged's city centre. Of the 522 respondents, 453 valid questionnaires were analysed. The results indicated that driver inattention and the unusual colour of tram-train vehicles were perceived as the main contributors to accidents, and more than half of the respondents suggested that increasing the visibility of the lower frontal sections could improve safety.

Eye-tracking studies using the Pupil Labs Pupil Core Eye Tracker examined drivers' visual behaviour prior to left-turn manoeuvres. Fixation maps showed that attention was primarily directed toward the lower and central frontal sections, particularly high-contrast elements such as yellow areas, orange signage, and red pantographs. These findings suggest that visual contrast strongly influences drivers' attention and that targeted vehicle design or infrastructure-related measures may contribute to accident prevention.

*Keywords: driver attention; eye-tracking; tram-train; traffic safety*

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## **(99) STRATEGIES FOR PREVENTING PIRACY IN HIGH-RISK AREA**

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### **Abstract**

The global economy relies on maritime security. More than 80% of global trade occurs via marine routes. Shipowners, shipping enterprises, and global marine authorities prioritize safety and operational efficiency. Maritime security issues such as piracy, theft, and smuggling must be addressed with utmost seriousness. The MV CMA CGM NILE, a notable cargo vessel of a leading maritime business, encounters perilous waves. The vessel navigates through regions notorious for piracy, such as the Red Sea. Enduring security protocols are vital to safeguard personnel, freight, and the vessel. This study assesses limitations and proposes strategic recommendations to enhance maritime security, particularly in high-risk areas. This research aims to comprehensively analyze these difficulties and provide viable solutions. This study employs descriptive qualitative data analysis. This study's conclusions aim to provide actionable recommendations for the MV CMA CGM Nile and other vessels operating on the same route to mitigate risks and improve worker safety. Investigative results: Unsuccessful anti-piracy initiatives, Inadequate security support tools and resources for high-risk maritime activities.

*Keywords: pirates;ship;sea;high-risk area*

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# (104) REMOTE MARITIME PILOTAGE: A PRISMA-BASED SYSTEMATIC LITERATURE REVIEW OF ACADEMIC RESEARCH

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## Abstract

Remote maritime pilotage has received increasing attention over the past decade as maritime navigation undergoes rapid digital transformation and progressive automation. Although technological capabilities have advanced considerably, research on remote pilotage remains fragmented across technological, operational, safety, human-factor, and regulatory dimensions. This paper presents a PRISMA-based systematic review of peer-reviewed publications from 2010 to January 2026. The objective is to consolidate current knowledge from selected studies, identify prevailing research directions, and clarify gaps relevant to practical implementation.

Searches in Scopus and ScienceDirect yielded 471 records. After removing duplicates, screening, and assessing eligibility, 23 studies were included in the qualitative synthesis, with 19 core studies explicitly addressing remote pilotage examined in detail. These studies were classified using a two-level framework comprising five primary domains - technological, operational, safety, human, and legal/regulatory each divided into three sub-domains.

The results indicate that current research predominantly focuses on communication reliability, integration of navigational data, human-machine interfaces, and bridge-shore coordination. Safety studies increasingly apply structured risk assessment approaches, while human-factor research highlights challenges related to situational awareness and workload. In contrast, regulatory frameworks and certification standards remain comparatively underdeveloped. The findings suggest that while remote pilotage appears technically feasible, its sustainable implementation requires further empirical validation, human-centered system design, and clearer governance structures.

*Keywords: remote pilotage; shore-based pilotage; e-pilotage; maritime navigation; safety*

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# **(105) INTEGRATED ANALYSIS OF NAUTICAL TOURISM INFRASTRUCTURE AND REGULATORY FRAMEWORKS IN CROATIA**

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*University of Split, Faculty of studies, 21000 Split, Croatia maritime*

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## **Abstract**

Effective management of nautical tourism requires, among other elements, an understanding of the infrastructure that supports it and the regulatory framework that governs service provision, navigational safety, and marine environmental protection. Croatia maintains a developed network of marinas, anchorages, and berths, whose characteristics help shape how coastal areas are used and how nautical tourism activities unfold. In parallel, the regulatory framework of Croatia and the European Union define the responsibilities of users and competent authorities through a range of legal provisions. This paper reviews the structure of nautical infrastructure and analyses key legislative elements relevant to its functioning. It is shown that a combined overview of infrastructure and regulations provides clearer insight into management requirements within coastal areas. The purpose of this paper is to establish a foundation for a systematic understanding of the relationship between nautical infrastructure and the regulatory framework, and to enable further investigation of key sectoral components, particularly the stakeholders and services that shape nautical tourism in the Republic of Croatia.

*Keywords: Type your keywords here, separated by semicolons ;*

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# (106) DEMAND-RESPONSIVE FLEET SIZING AND SCHEDULING FOR BATTERY-ELECTRIC AUTOMATED SHUTTLES USING A BENDERS DECOMPOSITION APPROACH

**Fabio Sartori Vieira, Fayçal Touzout, Angelo Furno, Nour-Eddin El Faouzi**

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## **Abstract**

First- and last-mile connectivity remains a major barrier to public transport adoption. Electric Automated Shuttles (EAS) are a promising option for demand-responsive feeder services, but their deployment requires integrating traditional service-design decisions with battery range limits and charging downtime.

Motivated by the MOB-AUTO<sup>2</sup> project, which operates an experimental EAS service on the A10 corridor between a park-and-ride facility and a multimodal hub south of Paris, we consider a bidirectional corridor served by a homogeneous battery-electric fleet over a day-ahead planning horizon. Passengers arrive throughout the day with heterogeneous desired departure times and maximum waiting tolerances. Each shuttle has limited seating capacity and state-of-charge constraints, and periodic charging at the depot removes vehicles from service.

We formulate an integrated fleet-sizing, timetable design, charging, and passenger-assignment problem. For a fixed fleet, the model minimises total passenger waiting time and penalises unserved requests, subject to travel-time, capacity, and energy-feasibility constraints. The resulting formulation can be expressed as a mixed-integer linear program and also lends itself to Benders decomposition by separating supply-side scheduling and charging decisions from passenger assignment. Computational experiments illustrate how charging constraints shape departure patterns and how service performance evolves with fleet size and demand structure.

*Keywords: electric automated shuttles; feeder services; fleet sizing; battery constraints; Benders decomposition*

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# (108) DATA-DRIVEN ALIGNMENT OF SAFETY AND QUALITY INDICATORS IN TRANSPORT MANAGEMENT SYSTEMS

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## **Abstract**

Technical complexity, regulatory fragmentation, and reliance on data-driven decision-making are listed as one of the main characteristics of modern transportation systems. In such a context, Safety Management Systems (SMS) and Quality Management Systems (QMS) represent management mechanisms designed to ensure an acceptable level of safety, regulatory compliance, and operational efficiency. SMS and QMS formally function as separate systems, but in operational practice, the same or similar sets of data are used as a basis for monitoring their effectiveness. This paper analyzes data-driven alignment of Safety Performance Indicators (SPIs) and Key Performance Indicators (KPIs) in transportation management systems, with a focus on the regulatorily limited, but operationally relevant, coordination between these sets of indicators. The research employs a qualitative, conceptual-analytical methodology that includes a structured review of scientific literature, a comparative analysis of regulatory frameworks, and an analysis of indicators, using an airline as an example. The results show that differences between SPIs and KPIs in most cases stem from interpretive, organizational, and regulatory requirements, rather than from different data sources. The work contributes to the development of a conceptual, data-driven framework for aligning safety and quality indicators in management systems while maintaining the functional and regulatory independence of the SMS. Concluding remarks include limitations of the proposed approach and guidelines for future interdisciplinary research.

*Keywords: transport systems; safety management; quality management; performance indicators; data-driven management; air traffic*

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# (109) MODELLING AND ANALYSIS OF TORSIONAL VIBRATIONS IN MARINE DIESEL ENGINE PROPULSION SYSTEMS USING SIMULATIONX SOFTWARE

**Karlo Bratić<sup>a</sup>, Nenad Vulić<sup>a,b</sup>, Đorđe Dobrota<sup>a</sup>, Francisko Lukša<sup>a</sup>**

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## **Abstract**

Torsional vibrations of the shaft line in the ship propulsion system are widely considered the most dangerous due to their potential to cause severe damage or cracking failures in the shaft line. To ensure the safe and reliable ship's operation, rules of classification societies and international regulations prescribe torsional vibration calculations and measurements. Torsional vibration analysis (TVA) is the mandatory requirement for all newly built ships within the ship design phase. TVA involves constructing the analytical or simulation model of the ship propulsion system to calculate natural frequencies, modes, torsional stresses and angular amplitudes and identifying resonance conditions in order to predict the shaft critical operating speeds. This paper presents torsional vibration analysis of the marine propulsion system with four-stroke diesel engine where calculations are obtained using simulation-based modelling approach. In general, the accuracy of analytical or simulation model is validated by comparing them with measurement data under real operating conditions, typically obtained during sea trials. The paper proposes model intended for implementation in the EneMar scientific project at the Faculty of Maritime Studies in Split, which involves the procurement of mobile equipment for measuring and analysing of torsional vibrations in ship propulsion systems.

*Keywords: torsional vibration; ship propulsion system; diesel engine; simulation modelling*

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# (110) WETTING STATES OF ROADS: MEASUREMENT MEANS AND INFLUENCE ON TIRE-ROAD GRIP

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## **Abstract**

The wetness of road surfaces is a crucial parameter for tire-road grip, and therefore for accident risk. An onboard water depth estimation system is evaluated on an instrumented vehicle after being validated against static methods. The achieved accuracy is at the millimeter level for water depth, with a frequency exceeding 1000 Hz, allowing evaluation on a vehicle traveling at relatively high speed. This system is then used experimentally to characterize the relationship between wetness and grip, first on a Griptester grip measurement trailer, and then on a full-scale test vehicle. Initially, it is shown that even shallow water depths of less than one millimeter significantly reduce grip, by 12 to 32%, for four reference road surfaces, compared to dry conditions. In a second phase, for high water depths, the conditions for aquaplaning are characterized depending on the speed of the test vehicle, from 30 to 110 km/h, and the wear of its tires. This work concludes with the importance of continuous onboard assessment of road wetness levels to provide relevant information to driver alert systems.

*Keywords: road wetness, water film thickness, tire-road grip, aquaplaning skid resistance*

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# (111) IMPLEMENTING SELECTED ADVANCED WAREHOUSE SOLUTIONS: A STUDY OF STRATEGIC DRIVERS, CRITERIA, AND PERFORMANCE IMPACT

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## **Abstract**

Advanced automated and robotic solutions have recently been widely introduced into warehouse operations, including receiving, storage, and order picking. An ability to operate continuously, with increased operational efficiency, greater utilization of space, and enhanced safety for goods and employees are some of the reasons why such solutions are gradually replacing traditional ones. This paper examines existing research on Robotic Compact Storage and Retrieval System (RCSRS), Robotic Mobile Fulfillment System (RMFS), Autonomous Mobile Robots (AMR), and Automated Guided Vehicles (AGV), with a focus on their key characteristics and application contexts. Furthermore, this study includes field research and interviews with warehouse system managers of relevant logistics companies. We consider the reasons for introducing such technologies, as well as the criteria that influence the selection of an optimal solution. This paper aims to compare the performance of traditional systems, characterized by a high proportion of manual labor in their processes, with systems that have implemented advanced warehouse solutions. This process involves assessing productivity, operational efficiency, and system throughput. The results of this research provide an understanding of how strategic motives, such as reducing labor costs, increasing operational efficiency, system throughput, and order fulfillment accuracy, influence decisions on implementing advanced technologies in warehouse systems. We contribute to the existing research by proposing a conceptual framework for decision-making that focuses on improving current warehouse systems through the selection of optimal technology based on operational requirements. Finally, we propose directions for future research in this area.

*Keywords: Robotic Warehousing; Warehouse Process Optimization; Performance Analysis; Technology Selection*

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## (113) POSSIBILITIES FOR THE APPLICATION OF ARTIFICIAL INTELLIGENCE IN SMART INVENTORY MANAGEMENT

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### **Abstract**

Inventory management is among the more complex segments of a business system, particularly in industrial manufacturing, due to the presence of two types of inventory: raw materials and finished goods. In the global business environment, characterized by highly dynamic market conditions, inventory optimization is becoming an increasingly demanding challenge. It requires coordination and systematic business planning supported by the application of innovative technologies. Increased demand volatility, the need for broader coordination among supply chain stakeholders, and inadequate or outdated management approaches lead to inefficiencies as well as inventory surpluses or shortages. The consequences include higher warehousing costs, losses due to write-offs and waste, and reduced responsiveness to rapid market changes. New, precise, flexible, and automated systems are required, as traditional approaches are increasingly unable to keep pace with market dynamics. Artificial intelligence (AI) introduces a significant transformation in inventory management. Its application enhances demand forecasting by analyzing historical data, seasonality, market trends, and external factors, generating more accurate forecasts for inventory optimization and reducing the risk of overstocking or stockouts. Optimal order quantities and replenishment levels are automatically proposed, ensuring a balance between storage costs and service levels. AI also enables the simulation of various scenarios, such as supply disruptions or sudden demand surges, and recommends optimal adaptation strategies. As a result, warehousing costs are reduced, product availability is increased, and overall business profitability is improved. In particular, real-time responsiveness to unexpected demand changes or supply chain disruptions is enabled, allowing supply plans to be dynamically adjusted. In this context, selecting appropriate AI algorithms is crucial. Therefore, this short review paper analyzes current challenges in inventory management and identifies areas where AI can address existing shortcomings. Furthermore, also a short overview of suitable AI algorithms is provided, along with the necessary prerequisites for implementing such systems.

*Keywords: inventory management; artificial intelligence; optimization; demand forecasting*

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# (114) SUSTAINABLE TRANSPORT LITERACY IN LATVIA: A NATIONAL ASSESSMENT VIA PILOT FEASIBILITY STUDY

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## **Abstract**

The latest National Travel Survey (NTS) conducted in Latvia shows that 87.6% of annual passenger-kilometres (pkm) were travelled by private passenger cars. By 2025, the share of electric vehicles in the national passenger car fleet for the first time exceeded 1% of the total number of registered cars, reflecting a gradual but still limited shift towards zero-emissions cars. The current modal split, with almost 90% of pkm in a year made by passenger cars, is widely considered unsustainable and remains the main target of transport policy interventions aimed at achieving greenhouse gas emission reduction targets in the road transport sector, which accounts for around half of total transport-related emissions. Given the above, assessing sustainable transport literacy is essential to understand the behavioural and knowledge-based factors that can contribute to reducing private car dependency. Sustainable Transport Literacy (STL) is a multidimensional construct capturing how individuals understand sustainable transport, how they evaluate it, how they act in daily mobility choices, and how confident they are in their own judgments. STL is operationalized through a structured assessment instrument based on four components: Knowledge, Attitudes, Behaviour, and Confidence in Judgment (K–A–B–C). The instrument allows for a balanced evaluation of literacy that goes beyond factual knowledge and includes behavioral and metacognitive aspects. The study uses a non-probability convenience sampling design to examine sustainable transport literacy among Latvian residents aged 15 to 84 in a pilot survey, which corresponds to the target population defined in the Eurostat European Mobility Statistics methodology. To assess representativeness, the sample distribution is compared with official population statistics provided by the National Statistical Institute. The survey results are preliminary feasibility findings based on the pilot survey. The findings provide an initial empirical baseline of sustainable transport literacy in Latvia and highlight gaps between knowledge and everyday mobility behavior. The proposed approach demonstrates the usefulness of STL as a diagnostic tool to support evidence-based transport policy and targeted educational interventions.

*Keywords: sustainable transport literacy; travel survey; modal split; Latvia*

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# **(115) INTEROPERABILITY AS A DRIVER TO BOOST EMPLOYMENT IN THE RAILWAY TRANSPORT SECTOR: EVIDENCE FROM ITALY**

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## **Abstract**

Interoperability is a key feature to ensure efficiency in railway transport across Europe and, thus, to benefit from the advantages of such transport mode, in terms of economic, environmental and societal impacts. However, several barriers still need to be overcome to guarantee the seamless and safe movement of trains, since differences among countries are present with respect to infrastructures, technology, operational conditions, and regulations. For this reason, the Interreg project T4Rail (Translate 4 Rail) IT-SI aims at implementing digitalization in communication procedures for rail transport services at the border between Italy and Slovenia, in order to eliminate language barriers and, consequently, reduce idle times to change crew at crossing points. In the context of the T4Rail project, surveys have been performed to investigate the potential of interoperability in boosting employment in the railway sector, also thanks to the use of technological innovations. Questionnaires have been developed to examine, on one hand, the approaches and requirements of railway companies when recruiting new personnel and, on the other hand, the perceptions and expectations of the general population and students regarding employment in the railway transport sector. The results coming from the administration of questionnaires to a sample of Italian respondents, reveal that the railway sector represents a niche market in which companies require very dedicated training and flexibility in working hours. At the same time, people show poor knowledge about professional roles in the railway sector, although they envision opportunities for competitive and stimulating jobs.

*Keywords: Interoperability; Railway transport; Employment; Cross-border services; Survey; Interreg projects.*

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# (116) MAPPING AIRPORT COMPETITIVENESS RESEARCH: A STRUCTURAL TOPIC MODELING

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## **Abstract**

This study systematically maps the thematic structure and evolution of research on airport competitiveness using Structural Topic Modeling (STM) applied to bibliographic abstracts. The analysis is based on a curated corpus of abstracts imported from Web of Science database and subjected to standardized text preprocessing, including lowercasing, removal of punctuation and numbers, and elimination of English and custom stop-words. Competing STM specifications ( $K = 3-20$ ) were evaluated using held-out likelihood, semantic coherence, and exclusivity, leading to an interpretable six-topic solution. Publication year is incorporated as a prevalence covariate, enabling the analysis of topic shares, correlations, and temporal dynamics.

The six topics capture core dimensions of airport competitiveness: (1) tourism and destination image; (2) logistics, service quality, and digital transformation; (3) connectivity, network and intermodal linkages with protection or risk considerations; (4) flight operations, regulation, and e-commerce or unmanned applications; (5) hub airports and productivity, strongly reflected in Asian civil aviation contexts; and (6) hydrogen-related supply chains and organisational drivers of innovation. Topic prevalence indicates that hub-productivity and logistics-digitalisation dominate the literature, while hydrogen and supply-chain themes remain marginal. Topic correlations are weak and predominantly negative, suggesting a high degree of thematic separation.

Temporal estimates reveal a gradual rebalancing of research priorities: traditional hub and logistics themes decline in relative importance, whereas connectivity/network and operational-regulatory topics gain salience. A focused comparison between 2015 and 2024 confirms the strongest growth for the connectivity/network theme and a moderate increase for the operational-regulatory theme. Overall, the findings provide a replicable roadmap of airport competitiveness research and highlight system integration and governance as emerging frontiers.

# **(119) HYDROGEN AS A MARITIME TRANSPORT FUEL: AN ANALYSIS OF THE INTERNATIONAL AND EU LEGAL FRAMEWORK**

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## **Abstract**

International regulations form the legal backbone of global maritime operations and serve as a foundation for national regulatory frameworks. Hydrogen, as a promising alternative fuel, could significantly advance the decarbonisation of maritime transport. However, its large-scale application requires not only technological innovations but also a robust and adaptable legal framework. Integrating hydrogen as a fuel into maritime operations poses challenges at both national and international levels, particularly regarding the harmonization of legislation in the areas of maritime safety, environmental protection, and operational procedures. This article explores existing global legal frameworks regarding the integration of hydrogen as a marine fuel. It analyses relevant legal instruments, including the IMO IGF Code, SOLAS, MARPOL, and examines the manner in which the European Union legal framework aligns its maritime decarbonization objectives with those established at the IMO level, particularly within the context of the Green Deal initiatives. Furthermore, it identifies regulatory gaps, particularly in hydrogen safety, certification, crew training, bunkering, and storage. The article contributes to the growing body of research on the legal aspects of using hydrogen as a fuel in maritime transport, linking implementation challenges with legal preparedness. This is especially important and useful for legislators and all stakeholders in maritime transport, as it will assist in further research into an appropriate legal framework for implementing hydrogen in the maritime transport sector.

*Keywords: hydrogen; maritime transport; legal framework; decarbonisation*

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# (120) ASSESSMENT OF TRAFFIC IMPACTS IN PORT AREAS THROUGH DYNAMIC ASSIGNMENT: THE CASE OF CATANIA (ITALY)

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## **Abstract**

Interactions between port areas and urban centres often generate critical issues related to road congestion and air quality degradation. To support sustainable planning, this study proposes a macro-to-micro modelling workflow applied to the case of Catania, Italy. A macroscopic model was used to define peak-hour demand and boundary inflow/outflow conditions, which were then transferred to a microscopic simulation with Dynamic Traffic Assignment (DTA), where vehicles iteratively adapt their route choices in response to congestion.

The results reveal marked oversaturation along the port–city interface corridor, with localized average speeds dropping to 5 km/h and significant queue formation. A detailed analysis of intersections and turning movements enabled the identification of the most critical nodes in terms of both traffic performance and environmental impacts. These findings provide a quantitative basis for prioritizing mitigation measures and for developing alternative mobility scenarios aimed at improving network efficiency and reducing the environmental effects of port-related traffic on the surrounding urban area.

*Keywords: Port–city interface; Dynamic traffic assignment (DTA); Traffic microsimulation; Scenario analysis; Transport planning*

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# (121) CROSS-VALIDATION OF PORT-RELATED SHIP EMISSIONS IN ADRIATIC PORTS: INSIGHTS FROM PER-CALL AND DOCKING-TIME METRICS

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## Abstract

Port-related emission inventories are widely used to support mitigation strategies and regulatory actions, yet their practical uptake is often hindered by the limited comparability of estimates and the large uncertainty associated with emission factors and incomplete activity data. Building on our previously developed data-driven framework, trained on environmental information from 728 maritime terminal-year observations, including 96 with detailed emission records, this paper advances the state of practice by introducing and applying a validation workflow specifically designed to check the consistency of expected ship emissions in Adriatic-Ionian ports. The proposed validation approach tests the consistency of port-level emission factors against reference distributions derived from the global dataset, using average values and standard deviations to quantify deviations and to highlight records that are inconsistent with the underlying activity profiles. The procedure is applied to Container, Cruise, and Ro-Ro traffic, considering emissions normalised both per ship call and per docking time. Results show that time-normalised indicators systematically exhibit lower dispersion than call-based metrics, supporting their use for robust comparisons across terminals when docking-time information is available. The validation also reveals that uncertainty is pollutant- and segment-dependent: PM and CO<sub>2</sub> are generally more stable than NO<sub>x</sub> and SO<sub>x</sub>, while cruise-related estimates display higher internal consistency than container and Ro-Ro records. These findings highlight the need for careful consideration when using expected emissions data affected by such uncertainties. Caution is required to avoid under- or over-estimating pollution associated with increases in traffic, changes in ship dimensions, or new terminal facilities. Likewise, unreliable estimates may lead to inadequate mitigation measures for environmental impacts during port stays, including fuel-use restrictions, shore-side electrification, or traffic limitations.

*Keywords: Port emissions; Docking time; Emission uncertainty; Maritime terminals; Environmental impact*

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# **(122) PROPOSED SEGMENTATION FOR IMPLEMENTING THE REACTIVE NETWORK-WIDE ROAD SAFETY METHODOLOGY ON REGIONAL ROADS IN ITALY**

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## **Abstract**

This study investigates the influence of roadway segmentation on the implementation of the reactive Network-Wide Road Safety Assessment (NWRSA) methodology on Italian regional roads. Existing NWRSA guidelines recommend homogeneous segmentation with relatively long minimum segment lengths, which may not adequately represent the geometric and functional variability of regional roads linking urban, peri-urban, and rural environments. A modified homogeneous segmentation framework is proposed, with homogenous segmentation criteria based on the carriageway type, number of lanes, horizontal alignment, area type and AADT where available. The minimum segment length is obtained from the maximum of crash location precision, junction predefined length, and measured geometric length. The method was applied to a 134 km section of SR2 (Via Cassia) using seven years of crash data. Results were compared with fixed-length 100 m segments and the recommended NWRSA segmentation. The modified segmentation approach reduced spatial fragmentation observed in fixed segmentation while limiting hotspot inflation associated with large homogeneous segments. The findings suggest that the proposed segmentation improves spatial coherence and risk representation in heterogeneous regional networks. The findings also provide a structured basis for segmentation within reactive NWRSA applications and may support more consistent implementation of network level road safety assessments.

*Keywords: segmentation; homogenous segments; network wide assessment ;road safety*

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# **(123) ENVIRONMENTAL, SOCIAL AND GOVERNANCE PRACTICES AT EUROPEAN AIRPORTS: INSTITUTIONAL BENCHMARKING AND IMPLICATIONS FOR POLISH AIRPORT GOVERNANCE MODELS**

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## **Abstract**

European airports are increasingly required to integrate Environmental, Social and Governance (ESG) principles into their strategic frameworks in response to climate policy, regulatory harmonisation and stakeholder expectations. However, the degree to which ESG has become institutionally embedded across European regions remains insufficiently examined.

This study analyses ESG maturity in selected European airports and investigates whether distinct regional governance models can be identified, with particular attention to Polish airports within the Central and Central-Eastern European (CEE) context. A composite ESG Maturity Index (ESG\_MI) is constructed using publicly available sustainability disclosures and strategic documents. Cross-sectional econometric modelling tests structural differences between Western European and CEE airports while controlling for airport size and regional economic conditions.

Results indicate significant regional differentiation. Western airports demonstrate governance-integrated ESG models embedded in strategic planning and accountability structures, while CEE airports exhibit investment-driven environmental modernisation with weaker governance institutionalisation. Polish airports present an intermediate configuration.

The findings suggest that ESG implementation in aviation should be interpreted as an institutional transformation rather than a uniform compliance outcome.

*Keywords: ESG, airports, sustainability governance, transport economics, air transport market, Poland;*

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## **(125) THE IMPACT OF VEHICLE FLEET AGE AND TRAFFIC VOLUME ON ROAD TRANSPORT EMISSIONS IN CROATIA**

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### **Abstract**

Transportation remains one of the key generators of pollution, making it a pivotal issue that needs to be addressed. Emissions of various pollutants present a significant contributor to the degradation of the environment and of public health. One of the key factors which causes pollution is the age of the vehicle fleet, since older vehicles were subject to different emission standards at the moment of their production. However, traffic activity also plays a crucial role in shaping overall emission levels. This study examines the relationship between trends in the average age of the vehicle fleet, traffic activity expressed through vehicle kilometers travelled (VKM), and road transport emissions in the Republic of Croatia. Several categories of emissions are included in the analysis. The study utilizes national data related to pollution and traffic activity. The results indicate that while the vehicle fleet in Croatia is gradually aging, emission intensity expressed per kilometer travelled shows a declining trend, reflecting technological improvements and the increasing contribution of newer vehicles to total traffic activity. At the same time, total emissions are strongly influenced by the growth in VKM, which offsets efficiency gains achieved through fleet modernization. A counterfactual analysis further demonstrates that, in the absence of traffic growth, total CO<sub>2</sub> emissions would have declined over the observed period despite fleet aging. The findings suggest that fleet modernization alone is insufficient to achieve sustained reductions in road transport emissions. The study can support policymakers in designing integrated measures to achieve national and European emission reduction targets, contributing to a more sustainable and cleaner transport system.

*Keywords: road traffic; traffic pollution; vehicle age; vehicle kilometres travelled; emission intensity*

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## (126) SENSITIVITY OF SOCIETAL RISK TO SHIP SIZE AND ACCIDENT TYPE IN LNG-FUELLED CRUISE SHIPS

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### Abstract

The growth of cruise ship size and the adoption of liquefied natural gas (LNG) propulsion require a structured assessment of societal risk scaling. This study develops a sensitivity framework to analyse how cumulative F–N curves respond to variations in vessel size and accident type within a Formal Safety Assessment (FSA) context. Hybrid event trees combining passenger-ship navigational hazards with LNG-related escalation pathways were applied to collision and grounding scenarios. Four reference cruise ships (40,000–180,000 GT) were modelled under invariant initiating frequencies and escalation probabilities to isolate consequence scaling effects. Results show that vessel size produces systematic horizontal amplification of fatality outcomes, with divergence between vessel classes increasing toward the low-frequency, high-consequence tail of the F–N domain. Accident-type sensitivity is non-uniform: collision primarily determines the vertical position of the societal risk curve, while the escalation structure governs tail behaviour. For the largest vessel class, partial exceedances of generic societal risk reference lines occur in the high-severity region, although risk remains within the ALARP range under revenue-based IMO criteria. The findings indicate that societal risk for LNG-fuelled cruise ships is primarily determined by exposure magnitude and escalation topology, rather than by fuel type alone. The proposed framework enables transparent separation of frequency, escalation, and vessel-scale effects in risk-based evaluation.

*Keywords: LNG; cruise ships; societal risk; accident analysis; risk assessment; event trees; F–N curves*

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# (129) APPLICATION OF DIGITAL TWINS FOR FAULT DIAGNOSTICS IN MARINE ENGINE SYSTEMS

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## **Abstract**

The maritime industry demands high reliability and safety in the operation of increasingly complex shipboard machinery, prompting a shift from traditional maintenance strategies toward Digital Twin (DT) technology. Despite rapid technological development, DT applications in the maritime sector remain fragmented and insufficiently validated under real operating conditions. This paper presents a systematic literature review based on the PRISMA 2020 framework, analyzing DT applications for marine fault diagnostics published between 2018 and 2024. The results indicate that while DT models demonstrate strong diagnostic performance for selected systems, particularly diesel engines and propulsion-related components, current research is predominantly limited to simulation-based studies. A significant imbalance in system coverage is observed, with electrical and maneuvering systems remaining under-represented. These findings highlight the need for standardized data architectures, integrated methodological frameworks, and cybersecurity-resilient solutions to support adoption of DT and enable future autonomous maritime systems.

*Keywords: Predictive monitoring, real-time data fusion, cyber-physical modelling, intelligent maintenance systems, autonomous fault analytics*

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## (130) SWOT ANALYSIS OF HYDROGEN FUEL IN MARITIME TRANSPORT

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### **Abstract**

The maritime transport sector is undergoing a significant transition toward decarbonisation and reducing GHGs (Greenhouse Gases), leading to significant interest in hydrogen as an alternative fuel. Hydrogen presents a promising environmentally friendly alternative fuel in maritime transport. However, its chemical and physical properties introduce specific safety challenges that require careful assessment. This paper employs a SWOT analysis to systematically evaluate the strengths, weaknesses, opportunities, and threats associated with using hydrogen as a fuel in maritime transport. Emphasis is placed on the key safety-related challenges and currently available risk mitigation strategies, all framed within a comprehensive SWOT analysis. The results highlight the necessity of early-stage integration of safety measures, specialised crew training, and cross-sector collaboration in developing standardised safety protocols. With effective risk management and proactive measures, hydrogen possesses the potential to become an important component of a safe and sustainable maritime transport future. The findings contribute to identifying priority areas for improving the safe implementation of hydrogen as a fuel.

*Keywords: hydrogen; maritime transport; safety; SWOT analysis*

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# **(131) ACCURATE MEASUREMENT OF TRANSPORT EMISSIONS USING REAL-WORLD VEHICLE DATA: A CROSS-BORDER POSTAL LOGISTICS CASE STUDY**

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## **Abstract**

Decarbonisation potential is among the most significant challenges currently facing distribution logistics. This article presents an analysis based on a cross-border postal operations pilot framework implemented between Slovenia and Croatia as part of the European Union (EU)-funded Advanced Multimodal Marketplace for Low Emission and Energy Transportation (ADMIRAL) project. The research focuses on moving from theoretical emissions estimates to high-precision, data-driven measurements using a global navigation satellite system (GNSS) logger to capture detailed vehicle trajectory data. The study applies a vehicle-specific power (VSP) model to calculate Well-to-Wheel emissions. The methodology, aligned with International Organisation for Standardisation (ISO) 14083 and the Global Logistics Emission Council (GLEC) framework, incorporates real-world variables such as vehicle dynamics, road gradients, and instantaneous acceleration, enabling a highly granular assessment of the carbon footprint. High-resolution data also show that aggressive driving behaviour and last-mile urban deliveries significantly contribute to overall emissions. These findings highlight the importance of dynamic, high-precision monitoring, systematic identification of inefficiencies, and robust validation of the environmental impact of logistics network optimisation.

*Keywords: Vehicle-Specific Power (VSP); GNSS trajectory data; Well-to-Wake emissions; Cross-border freight transport; Last-mile delivery emissions; ADMIRAL*

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## (132) QUANTUM OPTIMISATION FOR CONTAINER TERMINALS: A LITERATURE REVIEW

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### Abstract

Maritime transport accounts for a large share of global trade by weight. Containerised transport is growing globally and is expected to continue growing despite challenging geopolitical conditions. Due to this trend, the efficiency of port operations is becoming increasingly important for supply chain performance, sustainability, and resilience. Many key challenges in container terminal operations can be formulated as combinatorial optimisation problems and addressed with mathematical models for advanced optimisation techniques. However, conventional computing techniques can be time-consuming or lead to suboptimal results. Quantum computing (QC) is an emerging technology with high promises, particularly in combinatorial optimisation, where it is expected to offer a significant time-complexity advantage over conventional algorithms. This paper provides a structured review of quantum optimisation algorithms and related approaches for container terminal operations. We review the main application areas and summarise the methods proposed in the literature. Our results show that research to date has been scarce and has emerged only very recently. Based on these findings, we outline promising directions for future research and discuss pathways for integrating quantum algorithms into container terminal processes in the upcoming decades.

*Keywords: quantum optimisation; quantum computing; maritime transport; container terminals; terminal operations; literature review.*

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# **(133) DEVELOPMENT OF ROAD SAFETY IN EUROPE (2000–2020): DESCRIPTIVE TRENDS AND STATISTICAL ASSOCIATIONS WITH ECONOMIC ACTIVITY**

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## **Abstract**

Safety is an important aspect of life, work, and society, and it aims to minimise risks and prevent accidents, injuries, and diseases to protect life and health. Safety measures in the home, workplace or public space contribute to individual well-being and increase overall productivity. In the event of an accident or emergency that is not dealt with in a safety protocol, it may have a significant financial impact, and in the long run, investment in safety measures is more cost-effective. Safety considerations go beyond individual well-being, including environmental protection, waste management and compliance with ecosystem protection regulations. Identifying and mitigating potential risks is crucial to avoiding negative consequences when designing products, infrastructure and processes. Road safety is crucial for preventing accidents, injuries and deaths on roads. Implementing road safety measures, including traffic rules and speed limits, protects human lives and prevents collisions. Road users, including pedestrians and cyclists, are especially protected through designated roads and crossings. Road safety also contributes to economic stability by reducing the economic impact of accidents, ensuring efficient traffic flow and promoting environmental sustainability. The number of road accidents has decreased considerably, but its spatial distribution remains unchanged. Economic activity, i.e. GDP per capita, significantly impacts both mortality and death rates. The research concluded that Europe has experienced improvements in road safety and reduced mortality rates, stressing the significant impact of economic activity on these trends.

*Keywords: road safety, tendencies, influencing factors*

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## (135) APPLICATION OF LOGSTA-MARCOS MODEL IN TRANSPORT OF DANGEROUS GOODS

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### **Abstract**

Transport of dangerous goods requires constant control of the process and taking preventive actions to prevent possible consequences. One of the most important tasks in this field is to provide an adequate place for parking vehicles with dangerous goods during breaks. The aim of this paper is to show the applicability of the MCDM (Multi-Criteria Decision Making) model for properly selecting parking spaces for vehicles transporting dangerous goods. The paper shows the selection of one section per one direction on highway network: Niš – border crossing Gradina, direction toward Gradina. The objective LOGSTA (LOGarithmic normalization and STANDARD deviation) method has been used to determine the weights of four criteria, while MARCOS (Measurement Alternatives and Ranking according to Compromise Solution) has been applied to select two best locations among considered sets for the mentioned section. The scientific contribution lies in the fact that a unique integrated model has been applied, while the professional contribution can be manifested through support to decision makers in this field. Results show that A1 and A3 have the best performances to be selected as suitable locations for parking vehicles with dangerous goods. Comparative and sensitivity analyses confirm the original obtained results.

*Keywords: Dangerous goods; location; LOGSTA; MARCOS, transport.*

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## (136) CATEGORY ZONES OF CONFIDENCE (CATZOC) AND SOCIO-TECHNICAL RISK INDICATOR IN MARITIME NAVIGATION

**Alen Gospić<sup>a</sup>, Rino Bošnjak<sup>a</sup>, Joško Šoda<sup>b</sup>, Ivana Golub Medvešek<sup>a</sup>**

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### **Abstract**

Electronic Navigational Charts (ENCs) are essential tools for safe maritime navigation, yet their reliability largely depends on the quality of underlying bathymetric data. The Category Zones of Confidence (CATZOC) system is intended to communicate data uncertainty to mariners, but it is often misunderstood and inadequately integrated into operational decision-making. This paper proposes an interpretation of CATZOC as a socio-technical risk indicator features rather than a purely cartographic attribute. By integrating hydrographic standards with the Human Factors Analysis and Classification System (HFACS) and Systems-Theoretic Process Analysis (STPA), the study examines how CATZOC-related uncertainty propagates through the hydrographic navigational information chain and contributes to grounding risk. The research indicates that many grounding incidents traditionally attributed to operator error are more accurately explained as systemic failures involving technological limitations, cognitive bias, and organizational practices. It treats navigation not merely as a technical task but as a complex interaction in which technical uncertainty directly influences the human-in-the-loop safety margin. The CATZOC should be interpreted not merely as a cartographic attribute but as a critical safety parameter shaped by technological limitations, mechanisms of human error, and organizational influences across the hydrographic–navigational information chain. This chain defines the critical continuum of depth data, from acquisition and processing through cartographic production to bridge-level visualization via Electronic Chart Display and Information Systems (ECDIS). It can be concluded that a break or error at any point in this chain compromises the safety of the entire system.

*Keywords: Category Zones of Confidence (CATZOC), navigational safety, hydrographic data quality, Electronic Navigational Charts (ENC), human factors, HFACS, STPA, ECDIS*

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## **(137) TECHNICAL AND ECONOMIC ANALYSIS OF ZINC RECYCLING POTENTIAL IN THE MARITIME SECTOR OF MONTENEGRO**

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### **Abstract**

Zinc is a material of strategic importance in the maritime industry due to its high corrosion resistance and favorable electrochemical features, making it essential for cathodic protection systems. Modern circular and blue economy principles further emphasize the importance of recycling used zinc anodes, especially to reduce CO<sub>2</sub> emissions and promote the rational use of natural resources. Although a legal framework for metal waste management exists in Montenegro, zinc flows are neither systematically monitored nor recognized as a distinct material stream within the maritime sector. This paper, for the first time, introduces zinc as a specific category of waste in the national maritime-industrial context and highlights the discrepancy between its widespread use and its institutional treatment in practice. The research is based on a combination of SWOT analysis, material flow analysis (MFA) and technoeconomic evaluation in order to assess the recycling potential of zinc. The key generators of zinc waste are mapped, including nautical vessels, repair services, marinas and port infrastructure, along with critical points in the process of collection, selection and management of this waste. The results of the research and SWOT analysis show that the main advantages are the presence of a significant number of nautical vessels and maritime service companies that generate zinc, as well as its high recycling potential. Weaknesses include the lack of a specialized categorization of waste and domestic processing in Montenegro. The opportunities lie in developing collection and recycling systems, while the key threats are expressed through import dependence and insufficient recycling capacity.

*Keywords: zinc, recycling, SWOT analysis, MFA*

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## (138) INFORMATION SYSTEM CONCEPT DEVELOPMENT SUPPORTING BIKE TO SCHOOL PROGRAMS

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### **Abstract**

Parents driving their children to school generate air and noise pollution, reduces traffic safety around schools and does not encourage sustainable transport. Despite the benefits of bike-to-school programs, which promote safe, organized, and sustainable group travel for children, no comprehensive, scalable information service is currently available. Therefore, the concept of an information system supporting bike-to-school programs has been developed. To evaluate operational risks, key processes were assessed using a HAZOP methodology, identifying potential safety-critical deviations. Based on the identified risks, the database structure and the functions including registration, planning and tracking were developed. The proposed system integrates data collection, real-time monitoring, route management, and automated notifications for students, parents, teachers, and accompanying adults. The research provides a framework for future implementation and further development of digital mobility support systems for child cyclists.

*Keywords: Active mobility; Bike-to-School; Information System; HAZOP*

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# **(140) E-COUNSELING PLATFORM FOR SEAFARERS' SOUND MENTAL HEALTH: PROSPECT AND CHALLENGES TO IMPLEMENT GLOBALLY ON-BOARD SHIPS**

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## **Abstract**

The driving force of world trade is the maritime sector, and the power of this sector lies in its skilled, trained, and physically and mentally capable seafarers. Recent research has revealed that seafarers face various mental challenges at sea, such as sleep disturbances, stress, anxiety, loneliness, and others. This study aims to explore the feasibility of implementing an e-counselling service for the mental health support of seafarers. This study employs quantitative data from 120 responses from three key stakeholder groups: seafarers, shipowners/shipping companies, and mental health service providers/regulatory bodies. The findings reveal that 67.2% of seafarers have faced mental health challenges while on board. The most prominent issues were sleeping disturbances (75.4%) and isolation or loneliness (63.9%). A significant gap exists between the demand for and supply of mental health interventions, especially technology-based e-counselling support. Seafarers demonstrate a strong willingness to use e-counselling (85.2%); 39.3% consider it as effective as face-to-face counselling. All stakeholder groups identified significant benefits of e-counselling, such as primarily 24/7 access to professional help, flexibility, convenience, and enhanced privacy. However, major challenges were also noted, led by internet connectivity issues, data privacy concerns, and cultural or language barriers.

*Keywords: Seafarers' Mental Health; E-Counselling.*

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# **(141) MONETIZATION AND THE TREATMENT OF EXTERNAL AND WIDER ECONOMIC EFFECTS IN THE COST-BENEFIT ANALYSIS OF ROAD INFRASTRUCTURE PROJECTS**

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## **Abstract**

Cost–benefit analysis (CBA) is the principal framework for the economic appraisal of transport infrastructure investments in Europe. However, the practical treatment of project effects remains inconsistent, particularly regarding which impacts should be measured and monetised, and how they should be incorporated without risking double counting. This paper develops a structured framework that links the stages of impact identification, measurement, and monetisation, and applies it to the HEATCO typology of road infrastructure effects.

The analysis clarifies the distinction between direct effects, externalities, and wider economic impacts, and examines their appropriate role in welfare-based appraisal. The results show that indirect and multiplier effects are frequently misunderstood and sometimes incorrectly included in CBA, risking overestimation of project benefits. The study also highlights a widespread practice of limited monetisation, where only a subset of non-market impacts is valued to demonstrate project viability. In addition, many external effects are identified but not quantified, despite the availability of measurement methods and benchmark values.

The paper argues for more systematic measurement and monetisation of non-market impacts, updated benchmark values for key parameters, and clearer guidance on the treatment of wider economic impacts outside core CBA. By clarifying the role of different effect categories across the stages of appraisal, the proposed framework contributes to improving the transparency, consistency, and robustness of the economic evaluation of road infrastructure investments.

*Keywords: cost benefit analysis; road infrastructure; externalities; monetisation*

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# **(142) TYPICAL PROFILES OF PARTICIPANTS IN PEDESTRIAN-INVOLVED TRAFFIC ACCIDENTS IN SERBIA: A SYNTHESIS OF EXPERT FINDINGS AND OPINIONS**

**Jovana Zlajić** Error! Bookmark not defined., **Boris Antić**, **Dalibor Pešić** Error! Bookmark not defined., **Emir Smailović**, **Nenad Marković**

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## **Abstract**

Traffic accidents involving pedestrians represent a significant challenge in the field of traffic safety due to the vulnerability of pedestrians and their exposure to motor vehicle traffic. Despite continuous improvements in traffic safety systems, the risk of pedestrian accidents remains high. According to global statistics, approximately 1.19 million people die annually in road traffic accidents, with pedestrians accounting for about 23% of all fatalities. In Europe, around 20,000 road deaths occur each year, of which pedestrians represent approximately 18%. In the Republic of Serbia, about 3,000 road users lose their lives annually, with pedestrians comprising roughly one quarter of the fatalities. In the period 2019–2024, 747 pedestrians were killed and 15,431 were injured in Serbia, corresponding to an average of 129 fatalities and 2,572 injuries per year. This paper presents a synthesis of expert findings and opinions from traffic accident cases involving pedestrians in Serbia. The analysis covers accident conditions, participant characteristics, temporal and spatial factors, and typical behavioural patterns of pedestrians and drivers. Special attention is given to the statistical relationships among these variables in order to identify typical participant profiles in pedestrian-involved traffic accidents. The aim of the study is to identify and describe typical participant profiles in pedestrian-involved traffic accidents in Serbia, in order to improve the understanding of risk factors and support the development of targeted pedestrian safety measures.

*Keywords: traffic accidents; pedestrians; expert analysis; participant profile; road safety; pedestrian safety; road traffic risk factors*

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# (143) ENERGY IMPACTS OF AUTONOMOUS ELECTRIC VEHICLE BEHAVIOR AT PEDESTRIAN CROSSINGS UNDER MIXED TRAFFIC CONDITIONS

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*<sup>b</sup>KTI Hungarian Institute for Transport Sciences and Logistics Nonprofit Ltd.*

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## **Abstract**

Pedestrian crossings are critical elements of urban road networks, where frequent deceleration and acceleration events significantly affect vehicle energy consumption. With the increasing deployment of autonomous electric vehicles, new opportunities arise to optimize vehicle behavior in pedestrian-dominated environments. This paper investigated the energy consumption impacts of pedestrian-aware autonomous vehicle speed adaptation at unsignalized pedestrian crossings under mixed traffic conditions. A microscopic traffic simulation framework was developed using Vissim traffic simulation software, coupled with an external control algorithm that dynamically adjusted autonomous vehicle approach speeds based on real-time pedestrian movement and vehicle detection range. The model enabled a comparative assessment between human-driven and autonomous electric vehicles under realistic urban speed conditions. Several traffic compositions were analyzed, ranging from fully human-driven traffic to 100% autonomous electric vehicle penetration levels, with particular emphasis on the role of sensing capability. Simulation results showed that increasing autonomous vehicle penetration led to systematic reductions in system-level energy consumption near pedestrian crossings, primarily due to smoother speed profiles and fewer abrupt braking events. Longer pedestrian detection ranges further enhanced these benefits. The findings highlight the importance of pedestrian-aware control strategies in improving the energy efficiency of autonomous electric vehicles in urban traffic.

*Keywords: Autonomous electric vehicles; pedestrian crossings; pedestrian-aware speed control; energy consumption; mixed traffic;*

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# **(144) LINEAR PROGRAMMING MODEL FOR DEMAND RESPONSIVE BUS SERVICE ROUTE OPTIMIZATION**

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## **Abstract**

Low population density areas often face the problem that conventional public transport services cannot be operated efficiently, while providing high quality service. Demand-Responsive Transit (DRT) systems operate without fixed routes or a timetable avoiding unnecessary runs. The quality of DRT services is largely influenced by the travel time of passengers, therefore finding optimal routes for the vehicles is essential. In this paper, a linear programming model is developed for route optimization considering the travel time of passengers and the costs of the operator originating from the distance driven by vehicles. The model is validated through a simulation. The results show that depending on the balance between operator and passenger interests, optimal routes differ. Comparing the costs of the operator and the passengers shows that taking passenger interests into consideration when planning routes significantly reduces travel times, thus improving the quality of service.

*Keywords: demand responsive transit; vehicle routing; optimization; linear programming*

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## (145) RECONSIDERING ENGLISH FOR MARITIME LOGISTICS PURPOSES: IS GENERAL ENGLISH ENOUGH?

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### **Abstract**

Considering the importance of adequate reading comprehension of English-language texts across all domains of the maritime industry, this study aims to examine the extent to which high-frequency General English vocabulary enables comprehension of texts in the field of maritime logistics. Specifically, it investigates whether individuals with a good command of General English, but without prior knowledge of specialized vocabulary, can adequately understand such texts.

The study adopts a corpus-based approach, analyzing a corpus of 870,459 running words compiled from textbooks and academic materials in maritime logistics. Lexical Frequency Profiling was conducted using the AntWordProfiler 1.4.0w software, based on the BNC/COCA frequency lists, as well as the General Service List and the Academic Word List.

The results indicate that high-frequency General English vocabulary provides only limited coverage of the corpus, suggesting that it is insufficient for achieving adequate reading comprehension. A substantial proportion of vocabulary in the texts falls outside high-frequency word lists, pointing to the significant role of specialized vocabulary in this domain.

These findings highlight the need for early specialization among future professionals in the field, as well as the need for the development of domain-specific vocabulary within English for Specific Purposes instruction. In addition, they underscore both the value of, and the need for, a specialized frequency-based word list for maritime logistics.

*Keywords: vocabulary; lexical profiling; reading comprehension; maritime logistics; General English; English for Specific Purposes*

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# **(146) SPATIAL DISTRIBUTION OF MICROPLASTICS IN BOKA KOTORSKA BAY BASED ON ROV – ASSISTED MONITORING - PRELIMINARY RESULTS**

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## **Abstract**

Despite many recognized environmental pollutants, microplastics have been defined as one of the main polluters of the environment. Microplastics enter marine ecosystems in two ways: through the direct release of plastic particles and through the breakdown of larger pieces of plastic into the sea. Although plastic particles can be found in various forms and locations, the most significant research to date has shown that microplastics are mainly found in the surface or subsurface layer of the sea.

This paper aims to indicate the distribution and concentration of microplastics in different locations of Boka Kotorska Bay. Boka Kotorska Bay is an interesting area for research because of limited water exchange and heavy maritime traffic of a large number of vessels and cruise ships.

Using a modern Remotely Operated Underwater Vehicle (ROV), five water samples were collected at five different locations within the Bay of Kotor. Laboratory analysis investigated the amount of microplastics in the collected water samples. The preliminary results indicate that the highest concentrations of microplastics in the sea accumulate in places of increased flow of vessels, such as marinas and anchorages.

*Keywords: Boka Kotorska; Microplastics; Marine ecosystem; Pollution*

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# (147) NIGHT-TIME SHARED USE OF TRAMWAY INFRASTRUCTURE BY AUTONOMOUS BATTERY-POWERED PASSENGER PODS: A CONCEPTUAL FEASIBILITY ASSESSMENT OF ENERGY AND OPERATIONS

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## **Abstract**

Urban tramway corridors are capital-intensive assets that are often underutilized at night-time. In parallel, advances in autonomy and battery-electric propulsion enable small automated vehicles, yet classical Personal Rapid Transit (PRT) deployment remains constrained by the cost and complexity of dedicated guideway construction. This paper proposes and screens a concept in which small autonomous passenger pods (4–6 occupants) operate on existing tram tracks during night-time windows using temporal separation and dock/opportunity charging rather than continuous overhead electrification. A conceptual–analytical methodology combines deterministic vehicle dynamics energy modeling, charging-power sizing, tram infrastructure interaction checks (braking envelope, gauge/interface assumptions), temporal capacity envelopes, and a structured RAMS-oriented safety and regulatory risk assessment. Results from the reference scenario indicate energy intensities of 0.09–0.11 kWh/km, with auxiliaries and stop-and-go acceleration dominating consumption. The analysis suggests that mechanical feasibility is plausible, while the principal barriers shift toward detection/signaling compatibility, safety case demonstrability, and governance/regulatory classification. The paper positions the required digital control layer as analogous to capacity allocation mechanisms in city logistics, emphasizing that infrastructure reuse requires explicit slot allocation for track occupancy and charging nodes. The study clarifies the operational control architecture (central slot allocation vs. onboard autonomy), outlines a Safety Case evidence chain aligned with EN 50126/EN 50128/EN 50129, and provides hazard–mitigation–evidence and stress-test scenario summaries and provides a parameterizable feasibility framework to support subsequent microsimulation and pilot validation.

*Keywords: autonomous pods; tramway infrastructure reuse; night-time operations; battery-electric rail micro-mobility; energy modeling; RAMS; temporal separation; charging nodes*

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## (148) TOWARDS CLIMATE-RESILIENT PORTS: INTEGRATED RISK, MITIGATION, AND ADAPTATION STRATEGIES

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### **Abstract**

Ports are critical nodes in global trade and logistics, but they are increasingly exposed to climate-related hazards such as sea-level rise, storm surges, extreme weather events, and rising temperatures. These challenges threaten port infrastructure, disrupt operations, and create wider vulnerabilities across supply chains and regional economies.

This study develops an integrated analytical framework for climate-resilient port management, structured around four interrelated dimensions: risk assessment, mitigation, adaptation, and resilience. The research adopts a qualitative, literature-based approach, drawing on academic studies, policy documents, and institutional reports to synthesize current knowledge and address the fragmentation of existing port climate strategies. The findings show that mitigation, adaptation, and resilience measures are strongly interdependent and should not be implemented in isolation. In particular, strategies such as electrification, shore power deployment, and alternative fuel integration are most effective when combined with infrastructure adaptation and resilience-oriented planning. The study contributes to the literature by providing a structured, multi-dimensional framework that supports the integration of climate strategies in port systems. From a practical perspective, the framework offers a decision-support tool for port authorities and policymakers, facilitating more coordinated and sustainable approaches to managing climate risks.

*Keywords: climate change; ports; mitigation; adaptation; resilience; decarbonization; sustainable transport.*

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# (150) RENEWABLE ENERGY REQUIREMENTS FOR GREEN FUEL BUNKERING

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## **Abstract**

The decarbonization of the maritime industry requires a shift from conventional fossil fuels to green fuels, but the demand for renewable energy to produce these fuels and to bunker ships with them has not been quantified. This paper presents an analytical model to determine the renewable energy demand and photovoltaic (PV) surface area required for green fuel production and bunkering at Jebel Ali port, Dubai. The model replaces Very Low Sulphur Fuel Oil (VLSFO) with a fuel mix based on energy shares (60% green ammonia, 20% green methanol, 10% hydrogen, and 10% residual VLSFO) for two bunkering scenarios (Scenario 1: 100 Ultra Large Container Ships (ULCS) per annum, and Scenario 2: 200 ULCS per annum). The results show that the total renewable energy demand is 14,933 GWh/year (or 34.2 km<sup>2</sup> of required PV installation surface) in Scenario 1 and 29,866 GWh/year (or 68.3 km<sup>2</sup> of required PV installation surface) in Scenario 2. Most of the renewable energy demand arises from green fuel production, with bunkering pumps accounting for only 0.018% of total renewable energy. Green ammonia production accounts for 66.8% of total renewable energy demand, making it the key consumer. The transition from VLSFO to green fuels in the study also increases the total fuel mass by a factor of 1.83. The required PV installation surface area is substantial, indicating a need for solar farms outside the port area. The model provides a transparent, first-order framework for port energy demand, adaptable to other green-fuel portfolios and solar requirements.

*Keywords: green fuels, decarbonization, renewable energy, Jebel Ali, bunkering*

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## (152) HEAVY METAL ANALYSIS BY ROV – ASSISTED MONITORING IN THE ADRIATIC SEA – PRELIMINARY RESULTS

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### **Abstract**

Metals are an important factor in every aquatic environment, as biodiversity depends on them. They have always been naturally present in the environment, and their concentrations are regulated by natural processes. Heavy metals reach the oceans through natural processes and anthropogenic influences, the importance and contribution of which have increased in the last few decades.

By measuring the concentrations of toxic metals, we monitor human impact on the local and global scale, because the concentrations of many metals have increased due to excessive human exploitation of nature and industrial development. The research is based on laboratory analysis of sediment and seawater samples from three areas: the Bay of Kotor, the coastal waters of the municipalities of Dubrovnik and Neum. The samples were analysed using High-Resolution Inductively Coupled Plasma Mass Spectrometry (HR ICP-MS). To enable relative comparison among sites and among metals measured on different numerical scales, the concentration data were processed using log transformation and per-metal standardization. Within-area fold-based comparison was used to quantify the deviation of selected reference sites from local baselines, Fe-normalization was applied to sediment data as an additional matrix-control step, and principal component analysis was used to identify dominant gradients of spatial variability.

This paper provides the relative comparison of metal concentrations between sites and the identification of spatial variability using statistical methods (PCA and standardization). Concentrations of lead (82,01 mg/kg), copper (60,18 mg/kg), zinc (382,72 mg/kg), chromium (116,52 mg/kg) and arsenic (36,24 mg/kg) exceed the limit of possible negative impacts, while nickel (140,27 mg/kg) concentrations also exceed the limit indicating probable negative effects.

*Keywords: heavy metals; Eastern Adriatic; ROV*

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## **(153) POWER HARVESTING FROM TRAIN-INDUCED VIBRATIONS AT RAILWAY SWITCHES AND CROSSINGS**

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### **Abstract**

The increasing demand for sustainable railway infrastructure has driven interest in energy harvesting technologies for powering condition monitoring systems without batteries or wired connections. This study investigates the potential to harvest energy from transient vibrations at railway switches and crossings (S&C), which are characterised by impulsive forces and geometric discontinuities. Unlike continuous track sections, these environments exhibit non-stationary vibration patterns that are not well represented by harmonic excitation, an assumption that underlies most existing energy harvesting studies and limits their applicability to S&C conditions. A two-stage modelling approach is presented. First, a train-track interaction model is developed to predict vibration responses at S&C. The model efficiently captures track dynamics in the frequency range relevant to energy harvesting (20–200 Hz). Second, the predicted vibrations are used as input to a piezoelectric energy harvesting model to assess power generation and support the optimisation of harvester design. Results showed good agreement between predicted and measured sleeper vibration responses. The harvester was tuned to 60.6 Hz, corresponding to the dominant frequency of the S&C vibration, and achieved a maximum average power of 0.65 mW at an optimal load resistance of 2 k $\Omega$ . The modelling framework provides a basis for the systematic optimisation of energy harvesters for S&C applications.

*Keywords: Energy harvesting; railway switch and crossing; transient vibrations*

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## (154) REGULATORY MECHANISMS OF QUALITY CONTROL OF SEAFARERS' EDUCATION IN MONTENEGRO

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### **Abstract**

The education of seafarers is one of the key elements of the safety of maritime navigation and the consistent application of internationally accepted standards in maritime affairs. With the adoption of the new Law on the Safety of Maritime Navigation (LSMN) of Montenegro from 2025, a normatively more complex and institutionally developed quality control model for seafarers' education was established, based on a combined system of preventive and subsequent supervision. The paper analyzes the key regulatory mechanisms of this model, with special reference to the role of the Compliance Commission as an expert body in the process of issuing approval for the work of maritime educational institutions and seafarer training centers. Special attention is paid to the normative position of the Commission, the financial model of its functioning, as well as the relationship between preventive control of working conditions and subsequent supervision through the institute of inspection supervision. The analysis also raises the question of the institutional status of the Commission within the state administration system, especially with regard to its functional and organizational autonomy. The results of the research indicate that the new regulatory model represents a significant step forward in the direction of strengthening the quality standards of seafarers' education, but at the same time they identify certain normative ambiguities that require a more precise definition of the Commission's position and additional normative strengthening of the elements of its independence. This paper is based on a normative and doctrinal legal analysis of the relevant legislative framework governing the education of seafarers in Montenegro. The research relies on the interpretation of statutory provisions, combined with a functional assessment of institutional mechanisms established by the LSMN. In addition, while the primary focus is on the Montenegrin system, the analysis highlights a model that combines *ex ante* approval and *ex post* supervision as one of the possible regulatory approaches in the oversight of seafarers' education.

*Keywords: Compliance Committee; LSMN; regulatory oversight; education of seafarers*

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# **(155) COMPARATIVE ANALYSIS OF MARITIME EDUCATION IN CROATIA AND MONTENEGRO: THE CASE OF THE FACULTY OF MARITIME STUDIES SPLIT AND THE FACULTY OF MARITIME STUDIES KOTOR**

**Vera Kapetanović<sup>a</sup>, Maja Krčum<sup>b</sup>, Tatijana Dlabuč<sup>a</sup>, Igor Petrović<sup>a</sup>**

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## **Abstract**

The maritime industry is one of the key strategic economic sectors in Croatia and Montenegro. The geographical location on the Adriatic Sea, the long maritime tradition and the significant share of seafarers on the international labor market make maritime education an important segment of national educational systems. In Croatia, maritime education is carried out by, among others, the Faculty of Maritime Studies Split (FMSS), while in Montenegro the central role is played by the Faculty of Maritime Studies Kotor (FMSK) within the University of Montenegro.

The aim of this work is to perform a comparative analysis of the education of maritime students at these two faculties through an overview of the regulatory and institutional framework, the structure of study programs, teaching resources and infrastructure capacities, as well as through an analysis of the connection between educational institutions and the maritime industry. Special attention is paid to the organization of study programs, the relationship between basic and professional subjects, as well as the role of simulators and practical classes in the development of professional competencies of future Merchant marine officers.

The results of the analysis show that the maritime education systems in Croatia and Montenegro are largely aligned with international standards of seafarers' education, primarily through the application of the STCW Convention and corresponding national regulatory frameworks. Although there are certain differences in institutional capacities, infrastructural resources and the organization of study programs, both institutions successfully educate maritime experts who are competitive on the international labor market.

*Keywords: education of seafarers; international standards; structure of study programs.*

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# **(156) OVERVIEW OF METHODS FOR ASSESSING PASSENGERS' RIDE COMFORT IN RAILWAY VEHICLES FROM THE MECHANICAL VIBRATION POINT OF VIEW**

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## **Abstract**

Passenger railway transport is used to transport people within cities as well as between cities. Daily plenty of people travel by passenger railway vehicles for miles and spend their time in wagons. Their body is exposed to vibrations due to railway vehicle running on a railway track with irregularities, due to running in switches, and due to accelerations and deceleration as well as other dynamical effects. These vibrations affect the human body. Therefore, the main purpose of engineering in employed rail vehicle design is to produce as comfortable vehicle as possible. A level of passenger ride comfort is assessed during the designing phase mainly by means of simulation computations. There are several approaches to evaluate the ride comfort level in rail vehicles. The presented study includes an overview of the most common and used methods and methodologies, which are applied for assessment of ride comfort for passengers. The above methods show that the level of comfort is most often expressed by the driving comfort index, the calculation of which is defined in the relevant standards. Regardless of the method, values of accelerations detected in the measured points are the main input to calculations. Subsequent processing of acceleration signals depends on the considered method.

*Keywords: Railway vehicle; passengers ride comfort; mechanical vibration; methods; calculations*

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## **(157) SELECTED METHODS FOR ASSESSING THE RUNNING PROPERTIES OF FREIGHT WAGONS**

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### **Abstract**

Huge amounts of goods are daily transported by railway transport. It requires to have available suitable transport means, i.e. suitable freight wagons. Safety, reliability efficient and effective freight railway transport need to have freight wagons, which meet these requirements. Therefore, newly designed as well as modernized freight wagons must be analyzed and tested under strict conditions. These analyses and tests are performed by means of both simulation computations and real experiments. Conditions of analysis and testing are described in the related methods. The main goal of this study is to present principles of selected methods, which are focused on assessing the running properties of freight wagons. These methods are aimed at analyzing and testing evaluation of running safety, robustness of wagons structure and avoiding unfavorable cases related to a freight wagon position in a curve.

*Keywords: Freight wagon; railway transport; assessment; running properties; dynamics*

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# (158) FROM CHARTS TO DATA: SAFETY AND CYBERSECURITY CHALLENGES IN THE IMPLEMENTATION OF THE S-100 FRAMEWORK

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## Abstract

The International Hydrographic Organization's - IHO S-100 framework represents a paradigm shift from traditional chart-based navigation to data-centric navigation enabling the integration of hydrographic, meteorological, and safety-related information into modern navigational practices. This transition offers clear benefits in terms of situational awareness and decision support, but it also introduces new safety and security challenges that are not yet fully addressed in current implementation approaches.

This paper examines the safety implications of S-100 implementation, with particular emphasis on operational use and emerging digital risks. Based on a structured review of available literature, complemented by insights from professional practice, the study evaluates how increased reliance on digital data, system interoperability, and real-time information exchange may affect navigational safety. The findings indicate that, despite its potential to enhance safety, S-100 implementation introduces vulnerabilities related to data reliability, system dependency, and cybersecurity exposure. Furthermore, there is a lack of practical guidance on integrating these risks into existing safety management frameworks, particularly in operational contexts such as pilotage and coastal navigation. The paper highlights these challenges and proposes a practice-oriented perspective for a safer and more structured adoption of S-100-based digital navigation.

*Keywords: navigational safety; S-100; cybersecurity; pilotage; digital navigation*

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## (159) RISK ACCEPTABILITY CRITERIA IN THE SAFETY ANALYSIS OF OFFSHORE WIND FARMS

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### **Abstract**

This paper presents an integrated methodology for the quantitative assessment and management of maritime risks associated with offshore wind farms (OWFs). The approach is based on the IMO Formal Safety Assessment (FSA) guidelines, which were synthesized with German industry standards (BVBW, GL) to define specific, numerical acceptability criteria. A Risk Index (RI) based on frequency (FI) and severity (SI) indices was used, embedding it in a three-level acceptability classification (broadly acceptable, ALARP, unacceptable). A key element of the study is the implementation of the Relative Risk Method, along with RR (Relative Risk) and EER (Excess Event Rate) measures, which enables an objective comparison of farm design variants. The effectiveness of Risk Mitigation Measures was quantified using the Risk Reduction Factor (RRF). Additionally, based on the ALARP methodology, criterion values of environmental FN were proposed for the risk analysis of oil spills, which constitutes a comprehensive tool for assessing safety and environmental protection in the design of offshore wind farms.

*Keywords: offshore wind farms, navigational risk, FN curve, probabilistic risk assessment, Formal Safety Assessment, Maritime Safety.*

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# **(160) GENERATION Z AND MARITIME HIGHER EDUCATION: ENROLMENT TRENDS, RECRUITMENT CHALLENGES AND PROMOTIONAL STRATEGIES**

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## **Abstract**

Student recruitment has become one of the most pressing challenges for maritime universities. Generation Z has a very different approach to education, work, and career choices than the previous generation, and these differences have a direct impact on how maritime universities recruit and retain potentially valuable students. This article presents statistics on enrolment and graduation at two Polish maritime universities for the years 2015/ 16 to 2024/25, comparing data from Poland with other European countries and the results of global studies on maritime education. The analysis is based on published studies from Greece, Lithuania, Sweden, and the World Maritime University. The article also presents observations gathered during direct recruitment work as a university promotion specialist at education fairs throughout Poland, offering a practical perspective on how potential Generation Z students think, what motivates them, and how they respond to various promotional approaches. Based on this, practical recommendations are proposed for promoting maritime studies among this generation.

*Keywords: maritime education; student recruitment; generation Z; enrolment trend; promotion; seafarer shortage*

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# (161) LINER SHIPPING ALLIANCE PARTNER SELECTION VIA DEA AND GAME THEORY

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## **Abstract**

Strategic alliances help liner carriers share capacity, coordinate schedules, and expand networks under high fixed costs, yet poor partner choice and inequitable gains can destabilize coalitions. We propose a joint DEA–cooperative game framework for alliance formation. DEA ranks candidate partner coalitions by multi-dimensional input–output efficiency to quantify operational synergy. Cooperative game theory then derives fair benefit-sharing rules to sustain participation. A liner-shipment case study demonstrates efficient, stable partnerships for partner selection and negotiation in practice.

*Keywords: Data Envelopment Analysis; Cooperative Game Theory; Alliance Partner Selection; Horizontal cooperation*

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## **(163) ADVERSE ENVIRONMENTAL IMPACT OF CRUISE SHIPS ON COASTAL AND MARINE AREAS**

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### **Abstract**

Cruise tourism is a significant economic activity both globally and regionally, with steady growth over the past 50 years. Although cruise ships represent only 1% of the world's commercial fleet, their public image is often negative due to the numerous adverse environmental and social impacts on local communities. As the number and size of cruise ships have increased, growing public awareness of the negative impacts of the cruise industry on the environment has prompted the industry to address various environmental challenges. This has led to a range of sustainable and green programs, partnerships, and initiatives, making cruise ships, infrastructure, and related operations more technologically advanced and, therefore, more sustainable. This paper reviews the adverse environmental impacts of cruise ships on coastal and marine zones in different contexts, with particular attention to Marine Protected Areas. It also examines the legal framework, industry recommendations and guidelines, as well as various programs, partnerships, and projects related to the environmental sustainability of cruise tourism.

*Keywords: cruise ships ; adverse environmental impact ; marine and coastal areas ; Marine Protected Areas ; green transition ; sustainability*

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## (166) CHOICE-OF-COURT AGREEMENTS IN BILL OF LADING – WHICH EFFECTS FOR THE THIRD PARTIES?

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### **Abstract**

The bill of lading is one of the central legal documents governing the international carriage of goods by sea. The choice-of-court agreement, typically incorporated on the reverse side of the bill of lading, determines the jurisdiction competent to resolve disputes arising from the contract of carriage. Such agreements in bills of lading are concluded between the carrier and the shipper, and under the doctrine of privity of contract only those parties are generally bound by the rights and obligations arising from the agreement. In maritime transport the bill of lading is often transferred to a consignee or another third party (e. g. an insurer) that did not participate in the jurisdiction agreement, raising the question of whether the clause is binding on such third parties. Although privity of the contract itself presupposes that there is no binding effect towards the party not participating in the contract, comparative survey of national laws proves that there are different legislative and/or jurisprudential solutions.

In case of bill of lading effect of jurisdiction clause is mainly governed by national private international law rules of the forum which can lead either to the application of different international sources or the application of different national laws. Recent and relevant example of what it means in case of EU countries, with regard to the effects of jurisdiction clause in bill of lading for the third parties, is the CJEU's judgment in *Maersk*. The aim of this article is to give analysis of this judgment and its implications in Croatian law.

*Keywords: choice-of-court agreement, bill of lading, third-party holder, Maersk case, EU law, Croatian law*

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## **(167) THE INFLUENCE OF WINDS ON THE CRITICAL AIR VELOCITY IN A FIRE IN ROAD TUNNELS**

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### **Abstract**

The influence of winds and their gusts on the critical air velocity in longitudinal ventilation of road tunnels was carried out using a numerical model for the eastern tunnel tube of the Kastelec tunnel, and thus also the efficiency of the fans, which are necessary to maintain appropriate traffic conditions and safety in the tunnel. We paid special attention to the phenomenon of backlayering or smoke and air layers (stratification) at the critical (limit) air velocity, or at an air speed lower than the prescribed one, at which we can still effectively control the spread of smoke and thus provide the necessary time for the safe withdrawal of participants from the endangered tunnel pipe. The fact is that only after the safe withdrawal of road users can start putting out the fire. Simulations were used to analyze how winds (e.g. bora) affect the longitudinal ventilation system and cause backflow of smoke, which can endanger evacuation.

*Keywords: limit (critical) air velocity, road tunnel fire, emissions, ventilation, numerical model, retur*

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