SuTra 2022

International Conference on Sustainable Transport

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UNIVERSITY NORTH

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DURRËS

LÜRSSEN

BOOK OF ABSTRACTS

International Conference on Sustainable Transport |
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Welcome from the Chair | Preface to the first edition

Dear colleagues,

Welcome to the International Conference on Sustainable Transport – SuTra 2022!

The conference is jointly organized by the University of Rijeka, Faculty of Maritime Studies, Croatia and the University North, Croatia.

Globalization brings new challenges in transport of goods and people. In order to cope with the increasing demand for transport of all kinds, special attention must be paid to ensure the sustainability of modern transport. The SuTra conference focuses on multidisciplinary research and development, and operational experiences, with the aim of discussing optimal scientific and engineering solutions to reduce the negative environmental impact of transportation systems. This must necessarily be done through an interdisciplinary approach and taking into account the different transport modes: maritime, rail, road and air services, and inland waterways. The diversity of topics covered at the SuTra conference reflects the complex interactions between transport systems and their environment. The SuTra conference aims to bring together academia, industry and government, i.e., all the key players involved in ensuring the sustainability of the transport.

SuTra will be held in the beautiful city of Opatija, Croatia. Opatija, a magnificent coastal town on the Adriatic Sea and a famous health resort dating back from the 19th century, is now a popular holiday destination for tourists from all over the world. The mild and pleasant climate makes Opatija a perfect destination all year round. The town is surrounded by breathtaking nature. It is located at the foot of Učka mountain, a popular destination for hikers and excursionists, and forms the border between the green Istrian peninsula and the littoral region, which is characterized by a perfect harmony of different landscapes. The town of Opatija offers a magnificent view of the sea and the nearby islands of Krk and Cres, which can be easily reached by car or ferry. Opatija is surrounded by charming small towns with narrow streets and rich history. The city is easily accessible from the airports in Rijeka (40 km), Pula (100 km), Trieste (105 km), Ljubljana (130 km), Zagreb (180 km) and Venice (215 km).

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C o n t e n t s

P L E N A R Y   L E C T U R E

Challenges and Perspectives for the Reduction of Ship Emissions

Prof. Dr. Bettar el Moctar

Full Professor, Faculty of Engineering, University of Duisburg-Essen
Director of the Institute of Ship Technology and Ocean Engineering
Director of Model Basin Development Centre for Ship Technology and Transport Systems

The presentation gives an overview of the main challenges and perspectives for the reduction of emissions of seagoing, coastal and inland ships. The focus will be on the use of alternative fuels, propulsion systems and operational measures. First, the state of the art for the respective ship type is briefly presented. The advantages and disadvantages of the available technologies are discussed. Finally, the most promising ways of achieving zero-emission shipping are outlined.

KEYNOTE LECTURE

Putting European Mobility on Track for a Sustainable Future

Ms. Maja Bakran Marcich

Deputy Director General, Directorate General for Mobility and Transport of the European Commission

To support the transition to cleaner, greener, and smarter mobility, in line with the objectives of the European Green Deal the Commission has prepared a number of proposals to modernise the EU's transport system, also within the Fit for 55 package. By increasing connectivity and shifting more passengers and freight to rail and inland waterways, by supporting the roll-out of charging points, alternative refuelling infrastructure, and new digital technologies, by placing a stronger focus on sustainable urban mobility, and by making it easier to choose different transport options in an efficient multimodal transport system, the aim is to put the transport sector on track to cutting its emissions by 90%.

Analysis of the Transport and Warehousing Sector in the Republic of Croatia

Mladen Turuk, Davor Grgurević & Krešimir Buntak, *University North, Koprivnica*

Transport and warehousing activities are integral parts of the price of most products. During the Covid-19 pandemic, the sector, characterized by demand shocks, was further affected by high geopolitical instability and a sharp increase in fuel prices. The sector encompasses several activities including passenger and freight transport by road, rail, pipeline, water, or air, as well as supporting activities in terminals and parking lots, such as cargo transhipment, storage, and the rental of transport means and equipment, and postal and courier services. The paper analyses the data of the transport and warehousing sector in the Republic of Croatia for the period 2011-2020, using the method of analysis to further examine the individual activities of the sector on the basis of micro, small, medium, and large enterprises, as well as on the basis of different counties. The activities in the sector were mutually compared, while the key indicators of the sector were analysed using the descriptive statistics method based on secondary data obtained by the Financial Agency. The highest income was achieved in road freight transport, the highest profit in pipeline transport, while the largest number of people worked in the activities of providing universal postal service.

Advanced Image Processing Based System for Obstacle Detection on Rail Tracks

Milan Pavlović, Miloš Ristić, Petar Đekić & Biljana Milutinović
Academy of Applied Technical and Preschool Studies Niš

Rail transport is a very important part of daily passengers and freight transport. With its capacity and complex infrastructure, it occupies an important place in the economy and daily life. However, there are numerous safety risks that affect the regular operation of rail transport. From a safety perspective, level crossings are potential points of conflict and dangerous places because rail, road, pedestrian, and bicycle paths cross there. Regular level crossings should be lighted, marked, and provided with appropriate equipment. However, due to the varying needs of people, unregulated crossings are common. Such crossings are not designed, marked, and equipped with appropriate equipment or devices for safe traffic, and may occur at unsecured locations on the railroad infrastructure.

In general, any object located on the tracks and/or in their immediate vicinity, is a potential obstruction to safe rail traffic. The decision as to whether the object is an obstacle or not, as well as the assessment of the distance between the rail vehicle and the object in order to initiate braking if necessary, is made by the train driver. In order to make a correct and timely decision, the object must first be visible. However, in different weather conditions and poor lighting conditions, the visibility of the object can be very difficult, so that the correct and timely detection and estimation of the distance by the train driver can be uncertain. That may result in a delayed response and inability to stop the train in time, leading to a special hazard or traffic accident.

This paper presents the application of an advanced processing algorithm for obstacle detection on railroad tracks. The objective was to detect objects on the tracks in low-light conditions and at night, so that the tracks were detected first. Based on the track detection results, a Region-of-Interest (ROI) was defined, since not every object in the

scene is a potential obstacle. Detection of objects in ROI was performed using an image processing algorithm based on image segmentation techniques. Detected objects in ROI were marked as potential obstacles because they were on tracks and/or in their immediate vicinity. The experiments were conducted on site in low-light conditions and at night, examining different scenarios on a real functional railroad infrastructure in a rural area. The results showed that the use of this system in low-light conditions and at night can significantly increase the visibility of objects on the railroad infrastructure and improve the detection of obstacles and the safety of railroad traffic.

ITS and Telecommunications

Developing General Transit Feed Specification Data for Modelling and Simulation of Public Transit Network: A Case Study of Rijeka, Croatia

Neven Grubišić & Tomislav Krljan

Faculty of Maritime Studies, University of Rijeka

The General Transit Feed Specification, known as GTFS, is a standard public transit data collection and storage format. It contains datasets organized into a series of text files that provide information about public transport service, primarily: routes, trips with scheduled times, stop locations, stop times, calendar dates of service, etc.

Many cities and transit service operators around the world make this information available online in the form of GTFS feeds that can be used to develop models or applications based on this data. Applications include schedule optimization, trip planning for public transport, multimodal transport and sharing service connection, real-time transit information, etc. Transit feed data are also used in models and simulations at the mesoscopic or macroscopic level to generate valuable geo-based information and visualize traffic conditions. In addition, they are used for traffic analysis, transport planning, and traffic management.

This work focused on the development of the GTFS from the existing databases of the city of Rijeka, Croatia. The objective was to create aspecification for the static transit feed and to test the consistency of spatial and temporal information created with the traffic simulation software.

The methodology consists of several steps: first, data is collected from three different .csv files containing information on traffic routes, schedules, and stops. Then, preprocessing was required to obtain the correct format of the GTFS files. The

procedure includes cleaning errors and missing records, filtering and reorganizing data fields to adopt the structure required by the specification standard. For this purpose, the Python programming language was used. As a result, six .txt files were generated as minimum requirements representing routes, stops, stop times, trips, calendar dates, and agency information. Finally, the datasets were imported into simulation software to visualize them and test their functionality. The public transit simulation was added to the previously developed network and linked to private traffic demand.

The developed General Transit Feed Specification City of Rijeka contributes to the further development of IT-based applications and Smart City solutions for citizens and tourists. It is also the starting point for the development of real-time transit data as an extension of the static GTFS.

ITS and Telecommunications
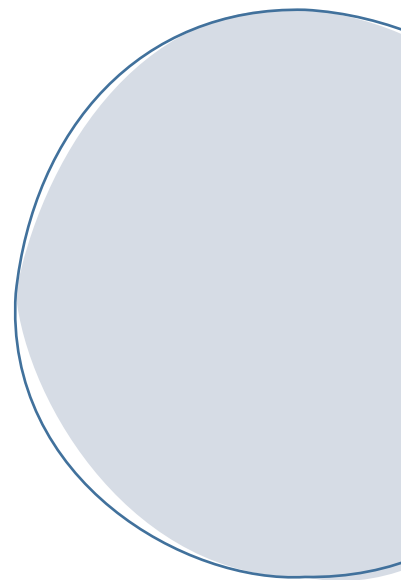
Digital Transformation of Sustainable Mobility Systems Using Artificial Neural Networks

David Kundih, Nikola Biškup & Krešimir Buntak

University North, Koprivnica

This paper binds the fields of artificial intelligence and sustainable mobility systems. The observed algorithm in this paper is an Artificial neural network, an essential part of the artificial intelligence model used to evaluate and predict the output based on the data set it's being fed. Through advanced systems it is possible to collect the necessary data for the creation of predictive models with high accuracy, but highly skilled data scientists and machine learning engineers need to evaluate all the collected features and compare the utility they provide to the artificial intelligence model performance and accuracy. The goal of this research is to explore the usage of Artificial neural networks in real-time object detection models that are targeted at sustainable mobility to provide insights for the creation of a well-designed and optimized system.

ITS and Telecommunications

Innovative Methods of Traffic Management in the City of Rijeka

Siniša Vilke, *Faculty of Maritime Studies, University of Rijeka*
Krešimir Vidović, *Ericsson Nikola Tesla, Zagreb*
Neven Grubišić, Jasmin Ćelić & Frane Tadić, *Faculty of Maritime Studies, University of Rijeka*

Promoting efficient and energy-efficient urban and multimodal transport in the city of Rijeka is one of the main tasks of the CEKOM Connected traffic scientific research project. The introduction of high quality and innovative solutions provides a better flow of urban traffic, while the application of energy efficiency measures reduces primary energy consumption and thus pollutant emissions.

The aim of this work is to use a simulation tool to test the application of new procedures in traffic management using the example of innovative dynamic scenarios in the city of Rijeka.

In the study, a methodology was applied to model the traffic network in the city of Rijeka and to measure traffic, environmental and meteorological parameters. The positive results of the traffic management system for several European cities were also analysed.

This paper presents the process of creating a traffic model developed to test traffic scenarios with regular and extraordinary events in the city of Rijeka. The application of simulations should contribute to the improvement of traffic management in the city of Rijeka through the output indicators of this project, such as a platform to support decision making and management of urban mobility.

ITS and Telecommunications

Maritime Information-Sharing Environment Deployment Using the Advanced Multi-Layered Data Lake Capabilities: EFFECTOR Project Case Study

Zdravko Paladin & Nexhat Kapidani, *Administration for Maritime Safety and Port Management of Montenegro*
Piero Scrima, *Engineering I.I., S.p.A. (ENG), Milano*
Georgios Vosinakis, *Institute of Communication and Computer Systems (ICCS), Athens*
Guillaume Hajduch, *Collecte Localisation Satellites (CLS), Paris*
Marios Moutzouris, *SATWAYS Ltd., Athens*
Christos Bolakis & Alkiviadis Astyakopoulos, *Center of Security Studies, Ministry of Citizen Protection, Athens*

Establishing an efficient information sharing network among national agencies in maritime domain is of essential importance to enhance the operational performance, to increase the situational awareness and to enable interoperability among all involved maritime surveillance assets. Based on various data-driven technologies and sources, the EU initiative of Common Information Sharing Environment (CISE), enables the networked participants to timely exchange information concerning vessel traffic, joint SAR & operational missions, emergency situations and other events at sea. In order to host and process vast amounts of vessels and related maritime data consumed from heterogeneous sources (e.g. SAT-AIS, UAV, radar, METOC), the deployment of big data repositories in the form of Data Lakes is of great added value. The different layers in the Data Lakes with capabilities for aggregating, fusing, routing and harmonizing data are assisted by decision support tools with combined reasoning modules with semantics aiming at providing a more accurate Common Operational Picture (COP)

among maritime agencies. Based on these technologies, the aim of this paper is to present an end-to-end interoperability framework for maritime situational awareness at strategic and tactical operations at sea, developed in EFFECTOR EU-funded project, focusing on the multilayered Data Lake capabilities. Specifically, a case study presents the important sources and processing blocks, such as the SAT-AIS, CMEMS, UAV components, including the C2 platforms for maritime information exchange in CISE format and communication patterns. Finally, the technical solution is validated in recently implemented project's maritime operational trials and the respective results are documented.

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Power Consumption Analysis of Wireless IoT Devices

Ivan Panić, Jasmin Ćelić & Aleksandar Cuculić

Faculty of Maritime Studies, University of Rijeka

Over the past decade, the Internet of Things (IoT) has become a widely recognized technology. IoT systems continue to grow exponentially, but power and energy consumption remains one of the most important aspects of implementing IoT at scale. As IoT technology expands, the demand for large-scale data collection requires rapid processing, storage, retrieval, and communication protocols. Big data can be retrieved by a large number of IoT devices with different collection, processing, and communication capabilities. The reliability, scalability, and deployability of wireless IoT systems depend on critical design and minimization of power consumption. This is especially true for IoT devices that are self-powered, use local energy storage or energy harvesting systems. Replacing and maintaining large scale battery-powered IoT systems with a large number of individual devices can be prohibitively expensive or extremely time-consuming. Therefore, the importance of extending the usable uptime of IoT devices is leading to an increasing demand for the implementation of specialized electronics as well as the development of communication protocols that can further reduce device energy consumption. This study compares and analyses the power consumption and energy requirements of wireless IoT devices, communication systems, and protocols deployed in smart cities and in the transport sector.

ITS and Telecommunications

Technological Aspects of Digital Transformation in the Maritime Transport Sector

Marija Jović, *Institute of Shipping Economics and Logistics, Bremen*
Edvard Tijan, *Faculty of Maritime Studies, University of Rijeka*
Burkhard Lemper & Frank Arendt, *Institute of Shipping Economics and Logistics, Bremen*

In the maritime transport sector, there are numerous stakeholders who need to collaborate and share information. Although digitalization and digital transformation can help facilitate data sharing, some of the stakeholders in the maritime transport sector still use traditional sharing methods that are no longer sufficient for sustainable business. Therefore, the research will examine the extent to which organizations in the maritime transport sector are aware of the positive impact of digital transformation and the methods they are using to accelerate it. The analysis is done from a technological perspective and includes the implementation of digital technologies and the associated risks, cybersecurity measures, interoperability, standards, and the need for new IT experts.

Logistics and Supply Chain

Beneficial Impacts of Digital Twins on Smart Factory Logistics: A Case Study for the Prefabricated Construction Industry

Bennet Zander & Kerstin Lange, *Department of Maritime and Logistics Studies, Jade University of Applied Sciences, Wilhelmshaven*

Smart factories and related logistics research have focused primarily on the largest industries without taking a closer look at the construction sector. However, significant changes are expected as a result of the European Green Deal, which will transform the entire industry. In the future, it will be possible to manufacture entire façade and roof elements for energy-efficient renovation of houses in decentralized automated factories.

The aim of this paper is to create a digital building twin and to analyse how high-resolution building object data can be used to monitor the procurement flows of a smart factory and to pilot logistics processes.

First, the digital twin (CT) is developed using the DT concept model. The building is evaluated with the DT fulfilment requirements. Then, a high-resolution building object is designed considering the three attributes of conceptualization, comparison, and collaboration. Afterward, a case study analysis is used to describe the use case and data generation to identify the beneficial impact compared to the current industry considering selected key performance indicators (KPIs).

The paper shows how the idea of Industry 4.0 and Smart Factories can be applied to the construction sector. The DT monitors material flows by quantity, location and time and can help improve logistics processes, especially purchase order accuracy and purchasing time.

Logistics and Supply Chain

The Impact of the Circular Economy on the Supply Chain – a Systematic Review of the Literature

Matija Kovačić, Maja Mutavdžija, Krešimir Buntak & Bruno Cesarec,
University North, Koprivnica

The objective of this paper is to analyse the impact of the circular economy on the functioning of the supply chain. The circular economy and its underlying principles are becoming the basis for sustainability development. Due to the growing concern about the excessive and irrational use of resources in the supply chain, which requires a different organization and approach to supply chain management, sustainability is becoming imperative. Based on the research, the authors who mainly focus on the impact of circular economy on the supply chain are presented, as well as the works that are most important in the context of scientific achievements on the impact of circular economy on the supply chain and collaboration between authors. The results of the research indicate an increased interest among scholars in the study of the circular economy and underscore the importance of the circular economy to the functioning of the supply chain. The research has a fundamental limitation related to the exclusive focus on the Scopus database and scientific papers without the inclusion of books.

Logistics and Supply Chain

Green Travel Planner and Infomobility Modular Software Platform

Dario Ogrizović, Ana Perić Hadžić, Mladen Jardas & Valentina Šutalo Šamanić,

Faculty of Maritime Studies, University of Rijeka

The Green Travel Planner allows users traveling between Italy and Croatia to calculate, compare, and select different routes based on their estimated CO_2 consumption depending on the distance and duration of the journey. Users will use the platform to plan their trip. They will enter their departure and arrival locations and travel dates, and click the "Search" button. The platform uses Google Maps to display the different travel options to the defined destination with the CO_2 values of the different routes. The platform promotes the greenest travel option throughout the user's journey starting from the purchase process to the destination. Green travel infomobility provides the option to sign up for the platform's support system, which will send users a series of messages about boarding/landing procedures and port mobility services. The use of instant messaging enables real-time management of critical situations for both users and providers, and ensures a fast and secure contact channel to avoid crowding. The first message comes immediately after the purchase and shows the amount (kilograms) of CO_2 consumed compared to the use of private vehicles. Then the user has to subscribe to the plan according to the GDPR legislation and receives the rest of the messages suggesting eco-friendly behaviour.

Influence of Blockchain Technology Application on Sustainable Supply Chain: A Review and Bibliometric Analysis

Ivana Martinčević, Katerina Fotova Čiković & Vesna Sesar,

University North, Koprivnica

Digitalization and new digital technologies create the conditions and are crucial for a long-term and sustainable survival in the market. Innovation and the constant and accelerated growth of new technologies are changing the way business has been done until now, as evidenced by the large number of newly available and technologically supported innovations. Given the advanced and rapid development of technology, we can claim that blockchain technology and cryptocurrencies are the future of supply chain management. On the other hand, sustainable development, and thus sustainable management, is a global goal, the fulfilment of which requires a long-term strategy to coordinate policies for economically, socially, and environmentally sustainable development, especially of the supply chain. Sustainable and quality management of a company with new technologies, such as blockchain, ensures the optimization of processes, minimization of resource consumption and maximization of other benefits associated with the business processes of the organization. This article presents a comprehensive bibliometric analysis of articles related to the application of blockchain technology in the supply chain and its impact on supply chain sustainability in the period 2017–2022, using the keywords "blockchain technology", "supply chain", and "sustainable" in the Scopus and Web of Science databases. The main objective of this work is to explore the applications of blockchain technology in the supply chain and its impact on supply chain sustainability, and to provide an analysis and visualization of bibliometric data to show the annual trends of published articles in this field, the top contributing journals, the most cited articles, the most contributing authors, citations, affiliations, and countries analysis, as well as an in-depth analysis of keyword visualization. The results of this study provide valuable insights and highlight the ever-growing trend toward the application of blockchain technology in

the supply chain and its impact on a sustainable supply chain. This article provides an overview of a research area that is poorly explored in the academic literature and presents a broad framework and guidelines for future work.

Logistics and Supply Chain

Machine Learning Validation Solution in Supply Chain Management

Patric Stanoiu & Luminita Parv, *Transilvania University of Brasov*

In recent years, technologies such as machine learning and artificial intelligence have become commonplace not only in computer science-specific research topics, but also in certain engineering fields. As the new industrial revolutions, i.e. Industry 4.0, continue to evolve, large amounts of data can be collected and used for further improvements. These data, grouped into large datasets, form the basis for research areas to improve cost efficiency and time management.

This paper aims to explore and validate a machine learning approach using a synthetic or semi-synthetic dataset specific to the supply chain. The main focus is to improve the quality of decision making and predictions. This can be achieved by training a neural network model capable of suggesting the best actions to take at a given time, by learning from existing use-cases. It should also provide a better understanding of the current load and contribute to better capacity planning.

Logistics and Supply Chain

New Approaches to Business Field Extension in Media Logistics: Cooperative Parcel Delivery

Christian Vollrath & Bernd Nieberding, *University of Applied Sciences Erfurt*

Demand for print media continues to decline. On the other hand, personnel costs for delivery continue to rise. This combination is leading to a sharp rise in the unit costs for delivery, e.g. of newspapers. Local and daily newspapers are particularly affected by this. To counteract this situation, media logistics companies are expanding their business areas to include complementary services such as mail or parcel delivery. The main aim of this expansion is to improve the utilization of existing transport processes and thus spread overhead-costs over a larger number of services provided.

However, expanding the range of provided services is a challenge. In contrast to daily newspapers with a defined local delivery area, the radius of action for the delivery of mail or parcels is much larger. Media logistics providers therefore use cooperative networks to cover the required area of their delivery services and offer postal services almost nationwide. In cooperative mail logistics networks, processes and prices have become established in recent years. In parcel delivery, media logistics companies are facing new challenges, especially in implementing cooperative delivery and main run processes with other network partners and establishing mutual service charges between different partners within the network. The latter is an important criterion for establishing cooperative delivery processes between partners. These charges can be negotiated and set statically for a certain period of time or can be formed dynamically depending on different influencing parameters, such as shipment volumes or fuel prices.

In this paper, all processes in a cooperative parcel delivery network are examined for the influence of dynamic parameters and monetarily evaluated. For this purpose, a

Total Costs of Ownership (TCO) model is used. The data on which the study is based were collected as part of the "Smart Multi-Use Logistics" research project. They are based on information about shipments and costs of a network of five Central German media logistics companies for the last mile delivery as well as one large parcel service provider and a freight forwarder for the main run processes.

Maritime and Inland Transportation

Criteria for Public Transport on the Drava River

Tanja Brcko, Jure Srše, Marko Perković & Peter Vidmar

Faculty of Maritime Studies and Transport, Portorož, University of Ljubljana

Inland navigation is considered an environmentally friendly mode of transport. It is energy efficient and has lower greenhouse gas emissions and greater cargo capacity compared to other modes of transport. Several factors need to be considered when developing passenger navigation on the Drava River. First, the general conditions need to be established, such as the number of passengers that would potentially use the waterway, the operating hours of the vessels, the locations of the planned stops, the location of the inland port, the service points, and other services that are urgently needed for the regulation of the waterway. Some important data include: restrictions of the river such as bridges and locks, flow velocity, width and depth of the river, regulatory and legal restrictions. Considering all these factors, this paper proposes a public passenger vessel that meets all the necessary criteria for the establishment of public transport on the river.

Maritime and Inland Transportation

Practice-Based Operability Limiting Criteria in the Adriatic Sea

Maro Ćorak & Srđan Vujičić, *Maritime Department, University of Dubrovnik*
Joško Parunov & Tamara Petranović, *Faculty of Mechanical Engineering and Naval Architecture, University of Zagreb*

The design process of ships is a very complex process that includes many segments and requires several iterations. One of the most important parts that affects almost the entire design process is the load and seakeeping analysis. An important analysis where seakeeping responses have a significant impact is the ship's operability analysis, which provides an estimate of the percentage of time the ship could be inoperable. Ship designers must have relevant criteria on which to base an optimal conclusion. Estimating the percentage of time that the ship could theoretically be inoperable depends on the limiting criteria for seakeeping, such as the frequency of occurrence of slams, green water, propeller emergence, pitch, vertical acceleration in the forward perpendicular, roll angle, and motion sickness criterion. These various limiting criteria for passenger vessels represent a number in theory than can be interpreted differently in practice during bad weather. This paper therefore gives a critical overview of the limiting criteria already analysed in practice and used in the operability study in the Adriatic Sea.

Maritime and Inland Transportation

Analysis of Ballast Water Discharged in the Port According to Origin and Ship Details (Case Study)

Nermin Hasanspahić, *Maritime Department, University of Dubrovnik*
Marijana Pećarević, *Department of Applied Ecology, University of Dubrovnik*
Niko Hrdalo, *Ministry of the Sea, Transport and Infrastructure, Republic of Crooatia*
Leo Čampara, *Maritime Department, University of Dubrovnik*

 Ballast water plays an important role in the transmission of Harmful Aquatic Organisms and Pathogens (HAOP) that negatively impact the environment, human health, and coastal economies. Therefore, in 2004, the International Maritime Organization (IMO) adopted the International Convention for the Control and Management of Ship's Ballast Water and Sediments (BWM Convention). The BWM Convention introduced the Ballast Water Exchange Standard (Regulation D-1) and the Ballast Water Performance Standard (Regulation D-2). As a result, ships are required to install ballast water treatment system (BWTS) as this is the most effective solution to comply with Regulation D-2. However, the deadline for installing BWTS has been extended to September 2024, and many ships still only comply with Regulation D-1. In addition, there are certain sea areas where ships cannot comply with Regulation D-1 (insufficient distance from land and sea depth), which increases the possibility of HAOP transfer between ports. Therefore, it is important to develop a management and control system to protect coastal areas from the introduction of HAOP. In this paper, the ballast water discharged in the Port of Ploče (Croatia) is analysed by ship type, size, age and flag. Moreover, the discharged ballast water was analysed according to its origin and it was found that 70% of the discharged ballast originates from the Adriatic Sea, but still poses a significant threat to the environment. Based on the results of the analysis, the paper proposes measures to reduce pollution from discharged ballast water.

Maritime and Inland Transportation

Analysis of the Use of Charts on SOLAS and Non-SOLAS Vessels from the Point of View of Navigational Safety

Jakša Mišković & Ivica Pavić, *Faculty of Maritime Studies, University of Split*

Josip Kasum, *Department of Forensic Sciences, University of Split*

The development of a system for displaying electronic navigational charts (ENC) has greatly improved the management of modern navigation. The provisions of the SOLAS Convention require the possession and use of the ECDIS system on ships engaged in international voyages. Under the current regulations, only a portion of SOLAS vessels are required to have ENC and systems to display this data. For other ships, this obligation applies only partially or not at all. The different standards that apply to SOLAS and non-SOLAS vessels mean that different systems and different types of navigational charts are used on these vessels.

Analysis of traffic load on the eastern Adriatic coast for 2019 shows an increase in maritime traffic, especially the domestic boat and yacht fleet, compared to 2018. Non-SOLAS vessels account for a significant share of the total traffic volume, which has a direct impact on the complexity of traffic flows. Under current regulations, vessels that do not have the same standard of navigational chart ownership and use also participate in maritime traffic. In certain cases, this can affect the situational awareness of seafarers, which is certainly a navigational risk.

One possible solution to the problem is to extend the application of the ECDIS rules of use to other SOLAS vessels. This would require an amendment to the SOLAS Convention. In addition, for non-SOLAS vessels, which account for a large part of the maritime traffic in the Adriatic, the obligation and development of new standards that would regulate the possession of a system for displaying official electronic navigational charts could be a possible solution. In this way, the standards for the possession and use of official electronic navigational charts that meet the requirements of maritime navigation could be harmonized.

Maritime and Inland Transportation

Assessing Carbon Emissions Reduction by Incorporating RFID Tracking System During Transit: A Case Study

Mohan Saini & Anastasia Efimova, *Tomas Bata University in Zlin*

The global maritime logistics activities are forced to improve their efficiency and also environmental performance by introducing a green concept in their operations. The main purpose of this research is to continuously monitor and track container shipments in ports to reduce carbon emissions and improve environmental performance. This research uses data from a case study showing an automated monitoring system to digitize logistics activities from the seaports to CFS by transmitting RFID data in near real-time to the server for tracking and tracing of container cargo. The data generated by digitization is mathematically analysed to ensure a green maritime logistics system. These values help to control fuel consumption and improve environmental performance by reducing carbon emissions. The results of the study, which are significant for the literature, show that the actual fuel consumption is reduced when the automated monitoring systems are used in ports (Ports and CFS). The reduced fuel consumption during transit between ports and CFS has led to a reduction in carbon emissions of environmental performance. The results show a 38% reduction in emissions from the port to CFS and 30% from CFS to the port. The results indicate significant carbon emission savings through effective Green Logistics practices in the monitoring system. These findings can help the top management of logistics companies in formulating effective strategies for the use of technologies in logistics operations to ensure green performance. The study was conducted under specific conditions that may vary by organization. In addition, other environmental dimensions can be used for performance monitoring as a future scope of the study.

Maritime and Inland Transportation

Effects of Global Warming and Increasing Maritime Traffic on Eutrophication in the Northern Adriatic Sea

Radoslav Radonja, Matija Šarić, Ivan Plješa & Vladimir Pelić

Faculty of Maritime Studies, University of Rijeka

The northern part of the Adriatic Sea is an area where numerous scientific studies on eutrophication of the sea have been conducted so far. However, these studies were mainly related to the increased nutrient input at the mouths of the major rivers, both on the Italian and Croatian side. More recently, it has been found that the increased nutrient input is also due to economic activities related to the sea itself, such as the development of coastal tourist infrastructure, but also the increase in nautical tourism and maritime traffic (especially cruise ships). In the context of the current energy crisis, an increase in maritime transport of oil and liquefied natural gas is also expected.

Given the increasingly evident trends of global warming and rising sea temperatures, the northern part of the Adriatic Sea (which is very shallow) could be further stressed. This paper examines the possible cumulative effects of such changes, especially from the perspective of maritime transport, but also gives an overview of the maritime transport legislation and the technical and technological solutions applied to modern ships, yachts and boats in this context.

In conclusion, the possibility of designating a particularly sensitive marine area with specific mandatory requirements for maritime transport may help reduce its impact on eutrophication, but also indicates that additional efforts must be made to reduce nutrient inputs from land.

Maritime and Inland Transportation

Encouraging the Use of Renewable Energy Sources through Remodelling of Port Tariffs on Inland Waterways – Port of Vukovar Case Study

Mark Černela, *Faculty of Maritime Studies, University of Rijeka*

The inclusion of sustainability as a business imperative in all transport sectors is presented as one of the main objectives in several EU documents. The creation of legal frameworks, guidelines and initiatives that could successfully shift traffic from land to inland waterways and rail would help relieve congestion on roads, which currently account for about 75% of all inland freight traffic.

Well-designed initiatives and incentives, if implemented properly, can greatly help individual ports attract more shipowners and more cargo by reflecting their intentions and visions of a greener future. The shift would also have a positive impact on greenhouse gas emissions. The objective of this paper was to review the financial documentation and performance indicators of Croatia's largest inland port and propose an alternative solution in pricing methodology to incentivize shippers to use Vukovar as a port of call for their future voyages. These proposed measures could help take a step forward in improving environmental performance and encourage a more environmentally friendly behaviour among the port users. The concept of strategically differentiating infrastructure charges to encourage more environmentally friendly behaviour, reduce emissions, or promote technological change can be used as a tool to transition to a greener economy.

The proposed measures aim to incentivize industry pioneers the results of which would bring about a highly desired environmental shift towards zero-carbon society and the sustainability of a port and industry in general.

Maritime and Inland Transportation

Environmental Requirements for Passenger Terminal Development (Case Study Zadar County)

Alen Jugović, *Faculty of Maritime Studies, University of Rijeka*
Daniela Gračan & Marina Barkiđija Sotošek, *Faculty of Tourism and Hospitality Management, University of Rijeka*

Cruise tourism as part of nautical tourism is an important segment of maritime passenger transport. Nautical tourism and cruise tourism have developed over the years and have recorded increasing demand, with the exception of the pandemic period when cruise tourism did not record positive trends. Under normal tourism conditions, high growth requires an increase in supply, which can have negative consequences for the environment. This is especially true if the destination where cruise tourism is developing has a fragile ecosystem. At a time when environmental sustainability and responsibility are becoming increasingly important, tourism supply is implementing the parameters of sustainability in its development, and cruise tourism is no exception. However, the fact is that the development of passenger terminals inevitably changes the view of the coast. This paper is about thoroughly defining the parameters whose reconstruction is necessary for the construction of a passenger terminal and analysing their impact on the environment in order to make the construction itself environmentally friendly. The analysis was carried out on the example of the construction of passenger capacity in the coastal region of Zadar County.

Maritime and Inland Transportation

Environmental/Safety Requirements for LNG Bunkering

Bernard Vušković, Igor Rudan & Matthew Sumner

Faculty of Maritime Studies, University of Rijeka

Liquefied natural gas (LNG) is a carbohydrate mixture composed mainly of methane that has been cooled to a liquid state for ease and efficiency of transport. Today, LNG is seen as a bridge for a global transition from fossil fuels to renewable energy sources. Although it is a fossil fuel, LNG emits fewer greenhouse gasses and carbon dioxide than other hydrocarbon fuels, making it an effective alternative for mitigating global warming. However, due to the global warming potential of methane, a predictable increase in methane emissions, such as from methane slip and other releases during the manufacturing and supply chain, could have harmful environmental impacts. Therefore, a regulatory framework has been developed to reduce the potential adverse environmental impacts while also increasing the benefits of using LNG as a fuel.

Maritime and Inland Transportation

Hydrogen-Powered Ferries Challenges

Roko Glavinović, Luka Vukić, Ivan Peronja & Gorana Jelić

Faculty of Maritime Studies, University of Split

As a part of the goal to significantly reduce greenhouse gas emissions by mid-century, research and deployment of alternative fuels is becoming increasingly important. The significant overall pollution from the shipping industry argues for an appropriate response, namely a switch to alternative marine fuels. Several projects are currently underway aiming to introduce hydrogen-powered ferries in Europe. This paper provides qualitative and quantitative data on the current possibilities of using hydrogen as a fuel in ferries. Compared to conventional diesel propulsion, the technological challenges, opportunities, and cost-effectiveness of hydrogen-powered ferries are discussed, especially from an environmental perspective.

Maritime and Inland Transportation

Insights into MET Practice – Exploring the Position of Instructors, Assessors, Supervisors

Srdjan Vujičić, Nermin Hasanspahić & Martina Hrnić

Maritime Department, University of Dubrovnik

The new technologies and STCW requirements place high demands and require highly qualified instructors and assessors, so standards must be established and well defined. Therefore, the authors have made a thorough analysis of the STCW Convention and Code, as well as of the relevant IMO Model Courses (6.09, 6.19, 3.12, 1.30). These courses are helpful, but in each of them it is pointed out that "the knowledge, skills and dedication of the instructors are the key components in the transfer of knowledge and skills". Qualified instructors are an invaluable factor in implementing the requirements set forth in the STCW Convention. Therefore, the authors examined the competencies required by MET institutions and competencies required by the Parties to the STCW Convention. The survey included 113 respondents in 26 countries that provide maritime education and training. The data were collected using an online questionnaire. Based on the findings collected, the authors provide recommendations for improving the training process in general. The main focus was on IMO Model Courses, training and qualifications of assessors and supervisors. This comprehensive survey can help the Administration of the Republic of Croatia and training providers to ensure a high-quality learning environment by training the trainers in accordance with the STCW Convention and Code.

Maritime and Inland Transportation

MASS IV: Cost-Effectiveness and Reliability of the Concept

Darijo Mišković, *Maritime Department, University of Dubrovnik*

The Maritime Autonomous Surface Ships (MASS) concept proposed by the International Maritime Organization (IMO) was introduced in 2018 and is divided into four autonomy levels. Level IV is intended for fully autonomous ships, which means that the ship should be able to make decisions and determine appropriate actions through its operating systems. The proposed benefits of the concept are increased maritime safety and environmental protection, and lower operating costs. However, there are other unexplored and/or undesirable consequences for the industry. These consequences primarily relate to the cost effectiveness and reliability of future ships. The cost-effectiveness and reliability of the concept is being studied in terms of the new design of the ship, navigation, communications and other equipment required for such an endeavour. In addition, the exclusion of humans from ships raises the question of who will be responsible not only for maintaining ships but also for managing loading/discharging operations, and what the quality, price, and ultimately the safety level of these services will be in the future.

Maritime and Inland Transportation

Near-Miss in Shipping: a Sign of Resilience or Vulnerability?

Nermin Hasanspahić, Srđan Vujičić, Miho Kristić & Maro Car

Maritime Department, University of Dubrovnik

In addition to injuries, environmental pollution, and loss of goods, shipping accidents can cause significant supply chain disruptions and negatively impact the global economy. Effective organisational learning from adverse events could improve maritime safety and reduce the number of accidents. Shipping is a high-risk industry where a corrective approach that includes accident investigation and analysis is considered a tool for organisational learning. Therefore, most safety measures in shipping are responses to serious accidents. On the other hand, there is a proactive approach in which the reporting, investigation and analysis of near-misses, which could be considered precursors of accidents, can be a starting point for maritime safety improvements. Proactivity, resilience, and reliability are considered key elements of shipping organisations. Therefore, implementing a proactive system in shipping, such as Near-Miss Management Systems (NMMS), could improve maritime safety, prevent environmental pollution, and increase the resilience of the global supply chain. Since near-misses can be seen as a sign of both vulnerability and resilience, this paper proposes to define resilient and vulnerable near-misses. It also discusses the definition of near-miss and the use of near-miss reports as a tool for proactive, resilient, and reliable shipping, with a focus on learning from near-misses.

Maritime and Inland Transportation

Reliability and Acceptance of Near-Miss System in Shipping

Miho Kristić, *Maritime Department, University of Dubrovnik*
Srđan Žuškin, *Faculty of Maritime Studies, University of Rijeka*
Nermin Hasanspahić & Srđan Vujičić, *Maritime Department, University of Dubrovnik*

The concept of near-miss reporting in shipping has the potential to improve safety at sea, especially if it is based on a reliable source of information. The core of the concept is the truthful near-miss reporting of events and/or conditions that could lead to a potential loss. In addition, serious reports are investigated to determine the underlying causes and to implement appropriate corrective actions. However, safety improvements can only be achieved if reports are truthful and reliable. If certain barriers to reporting exist, conclusions based on the near-miss system will be misleading, and the system will have significant flaws. The purpose of the proposed research is to determine the reliability of near-miss reporting and to identify barriers that affect the credibility of near-miss data. The basis for the research is a questionnaire completed by experienced seafarers. This paper analysed the survey responses by uncovering certain troubling aspects related to the truthful reporting of near-misses. Another troubling aspect is the seafarers' opinions on the ability of the near-miss system to improve safety at sea.

Maritime and Inland Transportation

Risk Assessment Outcomes for the Maritime Oil Trade

Peter Vidmar, *Faculty of Maritime Studies and Transport, Portorož, University of Ljubljana*

In recent years, the seaborne trade in crude oil has suffered from significant disruptions caused by the imbalance between supply and demand. The Covid 19 pandemic lead to a decline in oil consumption in 2019, followed by a decline in production in 2020. The paper presents the overall status of risk management for the crude oil tanker fleet as identified by EMSA and other international shipping organisations. Based on historical statistical data on fleet size, accident reports, the amount of oil spilled at sea, and the economic value of the crude oil transport business, risk acceptance criteria are assessed. The formal safety assessment is further used for systematic risk assessment where potential hazards are analysed using structured methods (HAZID and HAZOP) and presented in event trees. The paper examines three risks: PLL (potential loss of life), PLC (potential loss of containment), and PLP (potential loss of property).

Maritime and Inland Transportation

Strengthening Resiliency against Extreme Weather Events

Rainer Müller, *Institute of Shipping Economics and Logistics, Bremen*

Extreme weather events, for example heavy rain, storms, and heatwaves, impact maritime logistics and hinterland transport. When one mode of transport is disrupted by an extreme weather event, each logistics company attempts to shift its cargo to other modes of transport. Due to a lack of inter-company coordination, goods of all priorities are then shifted to the other modes of transport. Time-critical goods with the highest priority may have to wait. A centralised approach could coordinate shipments to strengthen the resilience and sustainability of transport chains. This study describes the concept of a centralised decision support system (DCS) that coordinates all shipments between a port and the hinterland through a designated inland hub. This intermodal hub will include inland waterways transport, rail and truck transport. It will also be closely linked to one port, allowing optimal use of barges and trains. Consequently, the modal split would favour a more environmentally friendly transport, thus increasing sustainability.

The DCS receives various input parameters, evaluates them and uses them to create a proposed course for action. In addition to the priority of the containers, transport capacities and various constraints must also be taken into account. The priority of the transport results from different parameters, e.g. time restrictions according to the transport planning, type of goods (e.g. perishable goods, pharmaceuticals) and special transports (e.g. refrigerated or dangerous goods containers). Extreme weather events may result in constraints, e.g. breakdown, temporary reduction in capacity or performance of a means of transport.

The DCS is implemented as a simulation with multiple simulation runs of different scenarios, with different extreme weather events. By evaluating multiple simulation runs, the resulting resilience enhancement will be qualitatively assessed and greenhouse gases reductions will be quantitatively assessed. The benefits of inland hubs in terms of transport efficiency have already been investigated in several studies. This study attempts to fill a research gap by evaluating the impact of an inland hub in terms of resilience and sustainability using a DCS.

Maritime and Inland Transportation

Sustainable Governance of Seaports as Key Components of the Emerging Concept of the Blue Economy: a Critical Review of the Maritime Industry and Future Research Directions

Miljen Sirotić, *Department of Management, Ca' Foscari University of Venice*

Alen Jugović & Tanja Poletan Jugović, *Faculty of Maritime Studies, University of Rijeka*

Ivica Krmek, *Maritime Department, University of Dubrovnik*

The recurring fact that there is no accepted definition of the emerging concept of the Blue Economy means that individual economic actors in seaports do not know exactly what the Blue Economy is, what it encompasses, and how it is applied. To bridge the gap between the different understandings of individual economic actors in seaports as key components of the Blue Economy, this paper conducts a bibliometric analysis of 210 journal articles on the emerging concept of the Blue Economy sourced from the world's most prestigious scientific database, ISI Web of Science. The bibliometric analysis revealed the most influential academic institutions, journals, articles, and authors based on citation analysis. The bibliometric co-occurrence method for the most frequently occurring author keywords of the selected top 10% of articles resulted in four research clusters: 1. the impact of ocean governance on seaports; 2. the impact of maritime policy and maritime security on seaports; 3. the impact of blue growth on seaports; and 4. the impact of ecosystem services on seaports. A content analysis will be conducted for each research cluster to provide a critical overview of the maritime industry and identify future research directions for seamless integration of sustainable governance structures at seaports.

Maritime and Inland Transportation

The Impact of Covid-19 Pandemic on the Financial Indicators of Maritime Companies in Croatia

Marina Brodarić Ivačić, *Brodospas, Split*
Luka Vukić, *Faculty of Maritime Studies, University of Split*

The Covid-19 pandemic has led to a mobility crisis, as isolation measures are mandated, physical distance must be maintained, and confined spaces must be avoided to limit the spread of the virus. In maritime transport, despite the significant increase in freight rates, especially in the container business, a slowdown in global activities has been observed. With nearly 80% of the world's trade being seaborne, maritime disruptions are impacting global trade flows and logistics supply chains. This paper analyses the impact of Covid-19 pandemic on the financial performance of shipping companies in Croatia, considering the most severe period in 2020. The research sample consists of the entire portfolio of companies designated as Water Transport Activities – NKD 50, according to the databases of the National Classification of Activities. Based on the monetary indicators and their comparison before and during the Covid-19 pandemic, the results indicate a negative impact on financial operations, which led to a decrease in most of the financial parameters studied. The pandemic affected the liquidity and business results of maritime companies in Croatia, challenging their sustainability and long-term development.

Maritime and Inland Transportation

The Impact of Port Infrastructure and Container Traffic on the Regional Development: Evidence from Port of Rijeka

Alen Jugović, *Faculty of Maritime Studies, University of Rijeka*
Helga Pavlić Skender & Petra Zaninović,
Faculty of Economics and Business, University of Rijeka

International transport of goods, especially maritime transport, is mainly based on container transport, and seaports and container terminals have a strategic importance for regional economic development. The Port of Rijeka is of strategic interest to the Republic of Croatia due to its geostrategic location in the northern Adriatic and its proximity to Central and Eastern European Member States. In order to take advantage of its location and opportunities, valuable and diverse infrastructure projects are being implemented in the Port of Rijeka. In this paper, we focus on the Zagreb Deep Sea Container Terminal infrastructure project, one of the most important components of the Rijeka Gateway project. The aim of this paper is to study the impact of container traffic in Rijeka on regional economic development and to predict the impact of future container traffic of the new Zagreb Deep Sea Container Terminal, which was taken over under a 50-year concession agreement with APM Terminals, part of AP Moller Maersk and Energia Naturalis (ENNA). Regression analysis is used to achieve the objective of the study and to estimate the impact of container traffic, but also to predict the impact of Zagreb Deep Sea container terminal on regional development. This research provides new

insights into the importance of infrastructural development and the opportunities and possibilities of the Port of Rijeka to position itself as an important logistics hub for EU maritime trade.

Maritime and Inland Transportation

The Structural Integrity of Aging Bulk Carrier's Inner Bottom Plating with Respect to Corrosion

Nataša Kovač, *Faculty of Applied Sciences, University of Donja Gorica*
Špiro Ivošević, *Faculty of Maritime Studies Kotor, University of Montenegro*
Nikola Momčilović, *Faculty of Mechanical Engineering, University of Belgrade*

The 2030 Agenda for Sustainable Development was launched in 2015 and established the 17 Sustainable Development Goals (SDGs). In addition, IMO has approved links between the maritime sector and the SDG goals, especially those related to sustainable production and the marine environment. Therefore, technical aspects such as sustainable ship structure and related analyses play an important role when it comes to reliability and overall safety in the marine environment. For instance, ship aging, particularly corrosion, affects the aging and structural degradation of ships, increasing the likelihood of structural collapse and fuel oil spills. Therefore, in this paper, we used an aging bulk carrier as an example to analyse nonlinear corrosion models to provide sufficient information for the design process and to ensure a sustainable structure during the exploitation. Nevertheless, numerous linear and nonlinear models have been developed in the last decades to describe the corrosion of various structural elements of ships. The models have been developed as a function of the presence or absence of protective surface coatings. Building predictive corrosion models based on historical data collected during ship operation was the best way to ensure optimal design of structural elements and ensure their structural integrity. Steel plate degradation data were studied to determine the intensity of corrosion of the inner bottom plating of fuel tanks on an old bulk carrier in service. The data on the measured thickness of steel plates during 20 years of operation were used to calculate the

corrosion models of millimetre degradation using a nonlinear model. Assuming that the corrosion process starts after 7, 8, and 9 years, the study calculates the corresponding coefficients based on a developed nonlinear model. A finer corrosion model is proposed to provide a sophisticated and tailored analysis of the effects of corrosion on the structural integrity of an element.

Maritime and Inland Transportation

Use of Fast Time Simulation Tool for Ship Manoeuvre Plan

Đani Mohović, Robert Mohović, Antonio Blažina & Marko Šuljić

Faculty of Maritime Studies, University of Rijeka

Ship handling can be defined as a science and as an art. Science because it requires theoretical knowledge of hydrodynamics and the various forces/moments acting on the ship. Art because it requires special skills that a navigator can only acquire with experience. Nowadays, some ships are worth more than 1 billion dollars and the people who control such ships must be well trained to have them under control at all times.

To improve the training and also the safety and efficiency of navigating real ships, the method of Fast Time Simulation will be used in the future. Even with standard computers, it is possible to simulate manoeuvres lasting up to 20 minutes in 1 second of computing time using simulation methods. The training process and the real manoeuvring process is significantly improved by such software. For this purpose, the Institute for Innovative Ship Simulation and Maritime Systems (ISSIMS) of the Maritime Simulation Centre Warnemuende MSCW has developed SAMMON (innovative "Simulation Augmented Manoeuvring Design and Monitoring"). The SAMMON toolbox system consists of software modules for Manoeuvring Design & Planning, Monitoring & Control based on Multiple Dynamic Prediction and Trial & Training. It is based on complex ship dynamic mathematical models for simulating rudder, thruster or engine manoeuvres under different environmental conditions.

The core modules of the Fast-Time simulation tools can be used to calculate manoeuvres up to the design of complete manoeuvring plans in the ECDIS environment. This software is an effective tool for lectures and demonstration of ship motion characteristics as well as for training in the ship handling simulator. It allows the user to immediately see the results of actual rudder, engine, or thruster commands without having to wait for real-time response from the vessel. It can also be used on

board the vessel for meetings prior to the arrival of real ships, to prepare manoeuvring plans for port approaches to the final berthing/unberthing of ships. It is also important to mention that the influence of wind and current on ships can also be simulated. The created manoeuvring plan consists of different segments divided by manoeuvring points where certain changes are made with the rudder, engine and thruster manoeuvring systems. These are interaction points, such as engine slow-down, wheel-over point or start thruster, instead of the commonly used geographic waypoints and route legs.

The fast-time simulation method is used to determine efficient manoeuvres and, most importantly, to create manoeuvring plans as part of the briefing for ship handling simulator exercises and practically for the route planning process on board. This planning process guarantees the full involvement of the bridge team involved in the manoeuvre. The best version of the manoeuvres can be found by trial and error, but it is possible to contribute all one's knowledge and to use one's skills; it is possible to see and check the results of one's ideas immediately and make sure that the intentions work. This is important for safety and efficiency, but also for gaining experience for future manoeuvres.

The Proposal of the New Categorization of Nodes and Trains – Case Study of the Čakovec – Varaždin – Lepoglava – Zabok – Zagreb Future High-Capacity Railway Line

Ante Klečina, Predrag Brlek & Ivan Cvitković, *University North, Koprivnica*

Kristijan Solina, *Croatian Regulatory Authority for Network Industries, Zagreb*

In this paper, a solution for a new categorization of train services and a categorization of nodes, i.e. railway stations and stops, is elaborated in order to create a fast, comfortable and efficient passenger railway service in northern Croatia. The proposal for the new future high-capacity railroad line Čakovec – Varaždin – Lepoglava – Zabok – Zagreb serves as a case study. The whole proposed line is also known as "Lepoglavska spojnica" or in English "Lepoglava connecting railway". This means that by combining trains of lower and higher categories, passengers will be able to travel faster in this region. Trains of higher categories have fewer stops and are faster. In addition, proper categorization provides the basis for designing an integrated system with clock-face schedule that provides the greatest number of connections at all possible nodes in the system. This is done to ensure full spatial and all-day accessibility of the entire region covered by passenger rail services and also by all other connecting (integrated) public transport services. The current categorization in Croatia is not customer-oriented and does not clearly define where a particular train category should stop and where it should connect to other train services or other public transport lines. This results in a service that does not meet the needs of customers. The proposed categorization is based on the findings from the literature and examples of good practice, the categorization of the rail services in Germany. The proposal is supported with the basic data on current transport demand, transport supply and demographics of the studied region.

Road Transport

Performance Evaluation of Advanced Algorithms for Traffic Flow Forecasting

Tomislav Krljan, Ana Grbčić & Tanja Poletan Jugović, *Faculty of Maritime Studies, University of Rijeka*

Nikola Lopac, *Centre for Artificial Intelligence and Cybersecurity, University of Rijeka*

In moderately developed cities, the realization of mobility desires today still depends heavily on the private transport system. Transitional cities, where demand for private transport modes is currently highest, face a number of problems. These problems are typically related to the level of traffic congestion, which leads to unacceptable travel times, fuel waste, lower operational efficiency, poor air quality, high driver stress levels, and safety concerns. Therefore, the need for effective short- and medium-term traffic flow forecasting is becoming increasingly important for the development of decision-support systems and the implementation of low-error operational procedures in traffic management. This paper evaluates the performance of advanced time series forecasting algorithms that ensure accurate future input data for traffic management decision making. The algorithms were trained, validated, and tested on a dataset of hourly traffic flow on a divided multilane highway (urban bypass) in 2021 (Rijeka, Croatia). The dataset consists of traffic flow data collected from inductive loop detectors on 10 highway sections (two detectors per driving direction; one detector on the right driving lane and one detector on the overtaking lane). The accuracy of the evaluated algorithms is assessed using performance metrics such as Mean Square Error (MSE), Mean Absolute Error (MAE), and Mean Absolute Percentage Error (MAPE). All tested algorithms meet the application criteria for detecting diurnal trends in traffic flow and are suitable for implementation in traffic management decisions.

Road Transport

Beyond High and Heavy: An Open Database Approach Facilitating the Transportation Planning Process

Kerstin Lange & Bennet Zander, *Department of Maritime and Logistics Studies, Jade University of Applies Sciences, Elsfleth*

Large-volume and heavy-load transports in XXL format exceed all dimensions at once. Length, width, height, weights and axle loads including cargo do not fit on normal routes. Extensive and cost-intensive route inspections are required in advance for the approval of such transports. The planning process for an XXL transport can take several months. It may be that more than 800 kilometres have to be examined for a transport distance of 30 kilometres, while the distance of a normal truck would only be eight kilometres.

Currently, XXL transports are not systematically recorded in Germany, so the existing knowledge cannot be used. The project "Conception of a knowledge-based database for XXL large-capacity and heavy-load transports (XXL-GST-Database)", funded by the Federal Ministry for Digital Affairs and Transport (BMDV), addresses this problem.

The aim of the research project is to facilitate the planning process of such transports with the help of an open source database. For this purpose, the standards of XXL transports are systematically analysed and categorized with parameters. Based on this database, data and information will be provided in the future, transport comparisons will be offered and combinations of transported goods, vehicles and routes will be shown before the final application for approval is sent to the relevant authority.

Road Transport

Conceptual Model for Determining the Statistical Significance of Predictive Indicators for Bus Transit Demand Forecasting

Bojan Jovanović, *Faculty of Transport and Traffic Sciences, University of Zagreb*

Kamer Shabanaj, *Ministry of Infrastructure and Transportation of the Republic of Kosovo*

Marko Ševrović, *Faculty of Transport and Traffic Sciences, University of Zagreb*

Conventional transit demand prediction models are typically developed based on data collected through empirical research and questionnaire surveys, and they primarily use historical data to predict the future transport demand characteristics. As a result, traditional transit demand prediction models are unreliable, because they often use only outdated transit demand data that are no longer meaningful for estimating future number of passengers and determining the expected public transport work on newly planned public transit lines. Traditional transit demand prediction models are also very inflexible, because they require historical data, collected over a long period of time, to estimate future transport demand. Another disadvantage of these types of models is the high cost of the empirical research that must be conducted to develop them. For this reason, conventional prediction models cannot be effectively used for agile and real-time predictions of transit demand characteristics.

Given the known drawbacks of the conventional approach to transit demand modelling, this paper discusses the possibility of improving the predictive capabilities of traditional forecasting models by leveraging the additional data contained in

existing Big Data systems. Specifically, the authors discuss the possibility of extracting the data contained in Big Data systems and using it to develop a model that can be used to determine the statistical significance of relevant predictive indicators in terms of their potential for estimating future transit demand characteristics along planned public transit routes. The data sources considered for extracting data on relevant statistical indicators primarily include the automatic fare collection systems, automated passenger counting systems, mobile network call detail records, border surveillance system records, tourist and visitor registration systems, accommodation reservation systems, bank record systems, student record systems, medical tourism records, and meteorological data systems.

Based on the available data extracted from the existing Big Data systems, a correlation and regression analysis was performed between various statistical indicators and transit demand volumes on the Prizen-Priština-Slavonski Brod-Zagreb international bus transit route in the period between 2015 and 2021. The relative statistical significance of individual indicators in predicting transit demand on the observed transit bus route was determined by comparing the values of correlation and coefficients of determination and the values of relevant statistical error measures, including the mean absolute error (MAE) and standard deviation of residuals (RMSE), obtained between the observed predictor variables and the actual characteristics of transit demand.

Based on the results of the statistical analysis performed, the authors proposed a conceptual model for determining the significance of various statistical indicators that can potentially be retrieved from the relevant Big Data systems in terms of their potential to be used as input predictor variables for modelling future transit demand characteristics on planned public transit lines. The results of the proposed model can be used as a basis for developing new dynamic forecasting models that allow faster and more reliable prediction of future public transit demand characteristics.

Road Transport

Effective Solutions of Traffic Calming in Urban Areas

Goran Kos, *Institute for Tourism, Zagreb*
Predrag Brlek, *University North, Koprivnica*
Zlatko Sovreski, *Faculty of Technical Sciences, Bitola*
Mario Šimunović, *University North, Koprivnica*

Requirements related to increasing traffic safety are the basis of the concept of "traffic calming", and the same is achieved by reducing the maximum speed of vehicles near kindergartens, schools, residential and commercial areas, etc., and improving the visibility of drivers, but also overall on the road. Speed reduction not only affects drivers, but also the safety of all other vulnerable road users (pedestrians, cyclists, children, disabled people), and reduces the immediate harmful effects on the environment – air pollution, environmental damage, reduction of noise levels, etc. In order to achieve all these goals, various measures need to be taken, such as reconstruction of the existing transport network, installation of signalization and special equipment to slow down traffic flow, introduction of effective and consistent regulatory measures, etc. The paper contains an analysis of the number of accidents depending on driving speed in urban and non-urban areas and presents some effective measures to reduce speed and thus increase traffic safety.

Road Transport

Population Mobility Trends and Road Traffic Safety in the Republic of Croatia Respecting the Covid-19 Pandemic

Ivan Cvitković, *University North, Koprivnica*
Tanja Poletan Jugović & Ines Kolanović, *Faculty of Maritime Studies, University of Rijeka*
Ljudevit Krpan, *University North, Koprivnica*

When the Covid-19 pandemic broke out in early spring 2020, Member States decided to close their borders to protect public health. The epidemiological situation due to the movement ban led to a drastic decrease in demand for transport and transport services. All the measures taken to protect human health were in fact aimed at preventing the free movement of people and their contact.

The subject of the study is the impact of mobility on transport safety in the Republic of Croatia in the conditions of the Covid-19 pandemic.

The aim of the research is to analyse relevant transport indicators and their impact on road safety, comparing the safety indicators in the years before, during and after the lifting of the restrictions imposed by the declaration of a pandemic.

The contribution of the research is to assess how the pandemic has affected mobility patterns and road safety as relevant indicators for future planning practice, and to examine how new knowledge is gained.

Research can help achieve global road safety goals by promoting pedestrian and bicycle travel and reducing air pollution. At the same time, it is a solution that can help achieve the European policy goal for road mobility and safety by 2030.

Smart and Sustainable Cities

Smart Security Logistics of Port Cities

Saša Petar, *University North, Koprivnica*
Elie Mina, *Beirut Arab University*
Husein Sakerwala, *Adani Enterprises Limited, Ahmedabad*
Mladen Jardas, *Faculty of Maritime Studies, University of Rijeka*

Although port cities have all the characteristics of cities without a port, they are developed in a way in which the city must adapt to the requirements and contents of the port as much as the port must adapt to the city. Therefore, security in port cities is of critical importance, especially after the warehouse explosion in Beirut on 4 August 2020, and the catastrophic consequences it had on the city, its economy, and its residents. Accordingly, this paper addresses issues related to the city-port nexus (economy, mobility, logistics, security), the differences between civil/commercial and naval port (organization, safety procedures, and others), as well as the growing impact of smart technologies on life and the economy, and what the application of smart technologies means for the development of port cities. This paper is the first part of a broader study that to be conducted to provide baseline information on smart technologies in the ports of Beirut (Lebanon), Mundra (India), Hamburg (Germany), and Rijeka (Croatia). The work will continue with broad interdisciplinary research focusing on logistics, security and smart technologies.

Smart and Sustainable Cities

Spatial Planning Documents as a Basic Precondition for the Development of a Quality Transport Infrastructure System

Ljudevit Krpan & Ivan Cvitković, *University North, Koprivnica*
Tanja Poletan Jugović & Ines Kolanović, *Faculty of Maritime Studies, University of Rijeka*

Spatial planning documents primarily have the task of shaping content in space. Thus, in the area of linear infrastructure system planning, they deal primarily with the transport, energy, and water management infrastructure. Herewith, we see the need to model an optimal transport network and prescribe conditions for its design that ultimately meet current traffic needs and avoid unnecessary space load and/or negative environmental impact as a fundamental task in infrastructure system planning. Therefore, the main hypothesis is: that only with a competent and systematic planning of transport networks in spatial planning documents, followed by the conditions prescribed for their design and construction, it is possible to ensure their full functional implementation. The aim of this paper is to analyse and evaluate the functionality of individual levels of spatial planning documents from the point of view of traffic planning. The purpose of this paper is to highlight the importance of understanding the individual levels of spatial planning documents and the conditions for the construction of traffic networks that each of the levels of spatial planning must meet. Indeed, overly strict implementation requirements at the level of strategic spatial planning documents can significantly limit the implementation of environmental impact assessment, especially if the document itself specifies a transport corridor that is not feasible from an environmental perspective. This paper assesses the role of strategic sectoral documents (transport and environmental and nature protection) in relation to spatial planning documents, focusing on the impact that sectoral strategic documents have on the final implementation of transport infrastructure projects.

Smart and Sustainable Cities

The Influence of ISO 37120 and ISO 37122 Indicators on Smart City Maturity: A Case Study of Croatian Cities

Maja Mutavdžija, Matija Kovačić & Krešimir Buntak,

University North, Koprivnica

Cities in the Republic of Croatia are striving to realize the concept of a smart city, which is why they are implementing numerous smart initiatives. The implementation of smart initiatives does not mark the cities as smart cities, but it shows that the cities have reached a certain level on the scale of maturity on the way to realizing the concept of a smart city. ISO Standards 37120:2018 and 37122:2019 provide a set of indicators to measure city service quality and indicators to measure smart city initiatives by 19 city subsystems. Through the conducted research, the maturity level of Croatian cities is assessed based on the indicators defined in the standards ISO 37120:2018 and ISO 37122:2019. The aim of the conducted research is to determine which of the 19 areas or subsystems of the city has the greatest impact on the current level of smart city maturity. The research was conducted on a defined sample of large cities with more than 35,000 inhabitants on the entire territory of the Republic of Croatia.

Urban Development Through a Smart City as a Sustainable Ecosystem

Katarina Stojanović, *Faculty of Hotel Management and Tourism, International University of Novi Pazar, Vrnjačka Banja*
Robert Čoban, *Color Press Group, Novi Sad*
Dejan Čavić, *Faculty of Hotel Management and Tourism, International University of Novi Pazar, Vrnjačka Banja*
Ivan Cvitković, *University North, Koprivnica*

A smart city is based on the concept of a sustainable city, which combines the idea of smart ecosystems through the use of information and communication technologies for environmental protection and spatial organization. Interdisciplinarity is necessary to survive in both sociological and cultural terms. It will help address modern challenges such as urbanization, immigration, overpopulation, traffic congestion, pollution, inadequate services, security and sustainability. The mutual interactions between different actors are presented with the aim of understanding cities as structures that need to be considered in the future as smart urban ecosystems that change over time. By analysing the literature on the ecosystem, smart and creative cities, we come to identify the management of the new city. The urban ecosystem collects, updates and analyses the problems of cities caused by the increasing complexity of economic, social, cultural, political and other functions. We propose modern solutions for designing cities as urban ecosystems that can overcome the increasingly negative effects of excessive urbanization, urban mobility, unhealthy lifestyles, etc. There is a global need to implement new ideas and systems that could change these negative impacts in the future.

Sustainable Mobility

An Adaptive Multi-Criteria Hybrid DEA Approach to Upgrade an Existing Bike-Sharing System with Electric Bikes: The Case of Ljubljana City Centre

Danijela Tuljak-Suban & Patricija Bajec,

Faculty of Maritime Studies and Transport, Portorož, University of Ljubljana

An e-Bike Sharing System (e-BSS) solves many of the shortcomings of BSSs – long distances, hilly terrain, are more convenient for the elderly and people with health problems – but requires large financial investments in e-bikes, charging stations, and battery replacement, if available, compared to BSSs. In this article, for the first time, a sustainable and targeted expansion of the existing BSS with e-bikes and charging stations is proposed. The BSS in the selected urban area is divided into subsets and subareas using the de Voronoi diagram and predefined landmarks. Then, the integrated approach of Analytic Hierarchy Process (AHP) and the Data Envelopment Analysis (DEA), supported by a comprehensive criteria system, is used to evaluate the suitability of existing bike-sharing stations for upgrading with e-bikes and charging piles. A defined criteria system considers the requirements of all stakeholders, the characteristics and needs of e-BSSs, and important sustainability dimensions. Finally, highly-efficient Data Envelopment Analysis (DEA) is used to rank the optimal bike-sharing candidate stations so that, given limited financial resources, only the most appropriate stations are upgraded, and not all stations. The aggregation of AHP and DEA allows decision makers to evaluate the entire process and highlight the relationship between the criteria score and the users of the selected location, which further strengthens sustainability. The testing of the proposed algorithm in the Ljubljana city centre confirms that different options for upgrading BSSs exist and are relevant, depending on the considered landmark.

Sustainable Mobility

Analysis of Student and Employee Mobility Towards the University Campus and Integration with Urban Areas

Vladimir Šimović, *Algebra University, Zagreb*
Katarina Stojanović, *International University of Novi Pazar*
Robert Maršanić, *University North, Koprivnica*

The first generation born and raised in times of increasing development and use of digital technologies is called Generation Z (born 1997 to 2012). This generation now represents the majority of students and they all use digital technologies intensively in their everyday lives.

The aim of this paper is to give a proposal or solution for managing and planning student flows in terms of achieving sustainable student mobility. First, the results of the survey on the state of the students flows on the university campus are presented. The results show that there is no coordinated transport strategy to meet the needs of students. Currently, there is low efficiency of networking between different departments and activities within the Campus and a low level of integration of spatial planning and mobility planning with the goal of improving sustainable urban mobility planning tools.

We propose a solution that includes the development of a mobile application that connects the campus the rail or all city transport to increase the use of public transport among students and align the city's public schedule with the needs of users.

This work is significant because the problem addressed and the proposed solution represent a starting point for building sustainable urban mobility for students and can be extended to other urban or suburban areas to involve the local population.

Sustainable Mobility

E-CHAIN Web Platform for Sustainable Passenger Transport

Valentina Šutalo Šamanić, Mladen Jardas, Ana Perić Hadžić & Dario Ogrizović,

Faculty of Maritime Studies, University of Rijeka

The E-CHAIN web platform will improve the efficiency, quality, safety and environmental sustainability of maritime and coastal passenger transport in the Adriatic region. The E-CHAIN web platform is developed using the PHP MVC framework Laravel, and MySQL database (back-end), while the client part (front-end) is built using the JavaScript framework Angular and Google Maps API. The GTFS (General Transit Feed Specification) and GTFS-real-time are used to exchange static and real-time public transit data (stops, routes, schedules, live departure times, service alerts, etc.). The E-CHAIN web platform is divided into three main functions: travel preparation (before the trip), support during the journey (to facilitate the relationship between customer and provider) and data analysis (for the port authority to analyse flows and improve transport performance in the port area). The potential for B2B, B2C and B2PA and the functionality of the E-Chain web platform are presented. The presented research was supported by the European Regional Development Fund, under the Interreg V IT-HR CBC programme, project ID: 10048282 (E-CHAIN).

Sustainable Mobility

Employee Sustainable Mobility Management

Predrag Brlek, Ana Globočnik Žunac & Nikola Biškup,

University North, Koprivnica

Planning of sustainable mobility is common at the national, regional or local level. This contributes to the creation of a sustainable community in economic, environmental and social terms. Today, such planning increasingly refers to lower levels of management, i.e. sustainable mobility planning in companies. The reason is that companies with their employees are one of the main causes of daily traffic, which causes many problems such as harmful emissions, noise, congestion and other problems. The planning of sustainable mobility in companies is called corporate mobility. The paper uses the method of discursive analysis of scientific papers and employee survey. The paper answers two identified problem questions. The first relates to the recognition of the importance of the problem of employee mobility in the scientific teaching of sustainable mobility, and the second relates to the possible solutions that business organizations can use to make corporate mobility more sustainable.

Sustainable Mobility

Key Performance Indicators (KPIs) of the Top 20 European Passenger Ports

Katarina Balić, *Expert associate for studies and students, University of Split*

Dražen Žgaljić, *Faculty of Maritime Studies, University of Rijeka*

Merica Slišković, *Faculty of Maritime Studies, University of Split*

Sustainable port key performance indicators (KPIs) are an important concept for port operations. This paper analyses the main scientific contributions in the field of key performance indicators for sustainable passenger ports and identifies the appropriate KPIs that influence the performance of passenger seaports. The KPIs for sustainable ports were examined from the sustainable port annual reports of the 20 largest European passenger ports and from academic peer-reviewed journals on port sustainability and key performance indicators. A search of the Web of Science Core Collection, which focuses on this topic, consists of academic papers published during the period 2013-2022.

Sustainable Mobility

Nautical Tourism Ports in the Function of Sustainable Development of Croatian Islands

Dea Aksentijević, Gorana Mudronja & Alen Jugović,

Faculty of Maritime Studies, University of Rijeka

Nautical tourism is an important factor in the development of the world maritime and economic system, and one of its fundamental characteristics is that it has a significant impact on the destinations to which it gravitates. The long maritime tradition and the relief characteristics of the Croatian coast are the basic conditions for the development of nautical tourism on the islands and in coastal destinations in Croatia. The nautical tourism ports represent a dynamic system that forms a unity in economic, spatial, structural and functional terms. Despite the numerous advantages offered by nautical tourism, it is necessary to look at it objectively and analyse its negative and positive sides. In this paper, the authors have analysed the economic, social and environmental aspects of nautical tourism and their impact on the development of Croatian islands. They have also determined whether the development of individual islands or their local self-government units should be based on nautical tourism.

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