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Book of Abstracts

Carpathian Logistics Congress

November 28th – 29th 2024

**AGH University of Krakow,
Krakow, Poland, EU**



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Lech A. BUKOWSKI

University of Dąbrowa Górnicza, Poland, EU

LOGISTICS 5.0: TOWARDS EFFECTIVE COLLABORATION BETWEEN HUMAN AND ARTIFICIAL INTELLIGENCE IN SUPPLY CHAINS

Abstract

The concept of Industry 4.0 was developed to improve the productivity of the manufacturing industry. Industry 5.0, on the other hand, embraces the principles of Industry 4.0, but evolves to harness the creativity of human experts in collaboration with efficient, intelligent and accurate artifacts to achieve human-centric solutions, and to include long-term resilience to disruption and ensure sustainable development principles. The article presents the genesis and difference of the above-mentioned approaches.

Dorota BURCHART¹, Radim LENORT², Marcin STANIEK¹, Josef HORAK², Iga PRZYTUŁA¹

¹Silesian University of Technology, Poland, EU, Katowice, Poland, EU,

²Skoda Auto University, Czech Republic, EU

ENVIRONMENTAL STRATEGY AND KEY INDICATORS ANALYSIS IN SUSTAINABILITY ESG REPORTING IN AUTOMOTIVE INDUSTRY

Abstract

Managing sustainability indicators in automotive industry are becoming increasingly important. The CSRD (Corporate Sustainability Reporting Directive) adopted by the EU Parliament changes the scope of corporate sustainability reporting. Sustainability ESG (Environmental, Social and Governance) reporting is based on international sustainability standards. Due to the fact that ESG reporting is obligatory in organizations, principles and elements of reporting the sustainable development of organizations in automotive industry are currently being developed. In the paper importance of the environmental strategy and challenges for the sustainability reporting of organizations in the automotive industry were presented. The paper also presents the ESG key indicators in the chosen organizations in the automotive industry.

Norbert CHAMIER-GLISZCZYŃSKI¹, Ondrej STOPKA²

¹Koszalin University of Technology, Koszalin, Poland, EU,

²Faculty of Technology, Institute of Technology and Business in Ceske Budejovice, Czech Republic, EU

ELECTROMOBILITY AS AN ELEMENT OF THE LOGISTICS SYSTEM

Abstract

When interpreting the issue of electromobility, we indicate the scope of operation and most often these are urban areas. It is in cities that actions are taken to limit, reduce the number of conventional vehicles and increase the number of cars with electric drive. On the other hand, AFIR (Regulation for the Deployment of Alternative Fuels Infrastructure) indicates the construction of charging stations for passenger cars, delivery vans and trucks with electric drive along the TEN-T (Trans-European Transport Network). The adopted recommendation extends the scope of use of electric cars to the entire area of Europe and not only in European cities. According to this recommendation, electromobility will be an

element of the European logistics system. The article presents the legal conditions and systemic approach to the network of charging stations for electric cars along the TEN-T road network in Poland. The aim of the article is to present electromobility as an element of the logistics system of Poland.

Jerzy FELIKS

AGH University of Krakow, Krakow, Poland, EU

TECHNOLOGIES AND TRENDS IN THE DEVELOPMENT OF INDUSTRIAL LOGISTICS

Abstract

One of the main goals of the economy is to meet the requirements of customers that change over time. Today, consumers are increasingly demanding individualized products with short delivery times. With increasing globalization, meeting these consumer needs has become an increasing challenge, so companies need new forms of production and logistics to meet this challenge in today's business environment. The implementing of new technologies will enable enterprises to respond and adapt to unforeseen disruptions by enabling a rapid return to pre-disruption status and even achieving new and even better quality and performance. In the article, the authors tried to answer the key research question, which can be formulated as follows: what is the current state of research on technologies supporting Logistics 5.0 in order to ensure the continuity of supply of human-centric goods and services, resilient to disruptions, and at the same time beneficial for sustainable development.

Helena FIDLEROVÁ, Jarmila BLAHOVA, Helena MAKYŠOVÁ

Slovak University of Technology in Bratislava, Trnava, Slovakia, EU

INNOVATION 4.0 IN LEAN MANUFACTURING: CASE STUDY OF THE ASSEMBLY WORKPLACE

Abstract

Variety of Industry 4.0-based innovation and their implication are introduced in companies in order to be competitive and to react more quickly to recent changes. Each industrial enterprise has its own concept, which includes a set of selected tools, techniques, and methods that are used to improve processes, build competences, and implement lean production. The aim of the contribution is to highlight the use of the chosen method of lean production on the basis of a case study at the inverter assembly workplace in the given company. Based on the theoretical definition of lean production methods and the analysis of the current state, in an industrial company we identified opportunities for improvement in logistics, and suggest the implementation of selected lean production methods and tools. The aim was to indicate potential of lean methods implementation in the context of the Sustainable Development Goal 9 Industry and Innovation to evaluate potential benefits and recommendations for practice.

Katarzyna GDOWSKA, Karolina OSIELCZAK, Roger KSIĄŻEK
AGH University of Krakow, Krakow, Poland, EU

SELECTED STRATEGIES FOR INTEGRATING HYDROGEN FUEL INTO TRANSPORTATION SYSTEMS

Abstract

This paper provides an overview of hydrogen fuel and its potential to revolutionize transportation systems. Hydrogen, with its various types – green, grey, blue, yellow, pink, turquoise, and black/brown – offers diverse possibilities for clean energy production. It delves into the production methods of hydrogen, including steam methane reforming, electrolysis, gasification, biomass gasification, pyrolysis, and thermochemical water splitting. The paper also explores hydrogen fuel storage solutions such as compressed, liquid, materials-based, and power-to-gas storage. These technologies are critical for ensuring the widespread adoption of hydrogen fuel in transportation systems. Furthermore, the paper examines strategic initiatives to promote hydrogen fuel adoption. It highlights Poland's hydrogen strategy and key European Union policies, including the European Green Deal, Fit for 55, the European Climate Law, and the EU Hydrogen Strategy. These initiatives aim to enhance the development and deployment of hydrogen infrastructure, positioning hydrogen as a viable alternative to traditional fuels. By investigating these various aspects – production, storage, and strategic planning – this paper provides a comprehensive understanding of the role of hydrogen fuel in the future of transportation. It emphasizes the importance of these strategies in ensuring the transition to a sustainable and low-carbon economy. Through the integration of hydrogen fuel, transportation can significantly reduce emissions, contributing to global environmental goals while advancing technological innovation.

Katarzyna GDOWSKA, Karolina OSIELCZAK
AGH University of Krakow, Krakow, Poland, EU

ENVIRONMENTAL AND ECONOMIC IMPACTS OF INTRODUCING HYDROGEN BUSES – A CASE STUDY OF KRAKOW'S PUBLIC TRANSPORT

Abstract

The need to reduce emissions from the transport sector and urbanization is critical, as climate change intensifies. The EU's Fit for 55 initiative aims to decarbonize the energy sector, promoting hydrogen as a clean energy solution for urban mobility. In Poland, a major emitter of CO₂ from transport, Kraków faces severe air quality issues and plans to implement a Low Emission Zone by 2024, including expanding hydrogen buses. Hydrogen-powered buses offer a zero-emission alternative to fossil fuels, overcoming electric vehicle limitations. The adoption of hydrogen buses requires careful planning, investment, and infrastructure development. This study analyzes the environmental and economic implications of introducing hydrogen buses on two Kraków bus lines, 128 and 304. A techno-economic framework compares hydrogen and diesel buses, assessing fuel consumption, emissions, and operational costs. The analysis finds that hydrogen buses reduce carbon emissions compared to diesel buses, with cost savings for both lines, though hydrogen delivery emissions impact the overall environmental benefits. The SWOT analysis highlights the advantages of hydrogen buses, such as their alignment with sustainability goals and operational efficiency, but also identifies challenges, including high costs and infrastructure development. Despite these hurdles, strategic investments, technological advancements, and public support could help Kraków lead in sustainable urban mobility, making hydrogen buses a promising solution for the future.

Robert GIEL

Wrocław University of Science and Technology, Wrocław, Poland, EU

RISK MANAGEMENT IN LOGISTICS: DIGITAL TWINS AND THEIR ROLE IN OPERATIONAL THREAT ASSESSMENT

Abstract

This paper explores the role of digital twins in enhancing risk management and operational threat assessment within logistics systems. With logistics networks facing increasing complexity and vulnerability to disruptions, the ability to predict, assess, and respond to risks has become crucial. Digital twin technology, a virtual representation of physical logistics assets and processes, enables real-time monitoring, simulation, and analysis, supporting proactive risk management strategies. By integrating digital twins with predictive analytics and artificial intelligence (AI), organizations can simulate potential risk scenarios, analyze vulnerabilities, and develop contingency plans to mitigate operational threats before they escalate. The paper reviews key applications of digital twins for risk assessment, such as monitoring supply chain resilience, forecasting equipment failures, and modeling the impact of various risk factors on logistics processes. It also examines how digital twins facilitate a continuous feedback loop, allowing logistics managers to adapt rapidly to unforeseen changes. The possible applications of digital twins focus on reducing downtime, improving decision-making accuracy, and minimizing financial losses in complex logistics environments. Finally, the paper discusses challenges associated with digital twin implementation, including data security, integration costs, and the need for advanced technical expertise. Findings indicate that digital twins significantly improve the capacity for early threat detection and efficient risk management in logistics, laying the groundwork for more resilient, adaptable logistics operations. Recommendations are provided for further development and refinement of digital twin applications to enhance logistical risk mitigation in an evolving operational landscape.

Oľga GLOVA VÉGSÖOVÁ

Technical University of Košice, Faculty of Mining, Ecology, Process Control and Geotechnologies,
Košice, Slovakia, EU

EFFECTIVE EVACUATION STRATEGIES IN CRISIS MANAGEMENT LOGISTICS

Abstract

This paper focuses on the key aspects of logistics in crisis management, emphasizing the planning of evacuation strategies and ensuring public safety during incidents involving hazardous substances. The study examines risk zone modelling and identifies procedures that enhance effective decision-making and coordination among response units. Particular attention is given to the challenges posed by rapidly changing conditions and the need for integrated approaches that bolster the adaptability of crisis management. The findings demonstrate that comprehensive logistical plans, based on precise modeling and well-developed evacuation strategies, are essential for minimizing risks and protecting the public in urban areas. The study underscores the importance of continuous improvement in planning processes and the integration of modern technologies to support safety and enhance the effectiveness of crisis response.

Hasan GÜNEY, Ahmet USTAOGU, Ahmet Yesevi TÜRKER, Tuğçe ELÇİ, Deniz KANTAR

Borusan Lojistik, Istanbul, Turkey

INTERNAL AUDITING IN LOGISTICS: AI-DRIVEN AND ADVANCED ANALYTICS SOLUTIONS

Abstract

Internal auditing is important in ensuring compliance, increasing operational efficiency and protecting assets in the logistics industry. However, the increasing complexity and data density of logistics operations make traditional control methods insufficient. This requires the integration of artificial intelligence (AI) and advanced analytics into internal auditing. The large volume of data generated in logistics exceeds the processing capabilities of manual controls. Artificial intelligence solves this issue by quickly and accurately analyzing large data sets. Moreover, AI enhances the detection of anomalies and risks through complex algorithms, enabling proactive and predictive audit approaches that detect problems before they escalate. In this paper, artificial intelligence is used to scale down large volume of data. Thus, instead of handling large volume of data manually, a more efficient process can be carried out in problematic, erroneous or suspicious transactions. The paper gives solutions to situations such as fraud in additional service and fuel payments, identify anomalies in trip durations, and pinpoint route discrepancies. To achieve these goals, unsupervised learning tools such as Isolation Forest, DBSCAN, and Local Outlier Factor, along with statistical methods like Z-Score, have been employed. The use of artificial intelligence in internal audit helps increase transparency in shipping operations, maintain cost control and ensure operational efficiency. In this way, it enables faster, more accurate and effective internal audit processes in the logistics industry and has the potential to set a new standard in the industry by enhancing safety and accuracy in transportation activities.

Cornelius HAKE^{1,2}, Jonas WEIGELE¹, Benjamin KRAUSS¹,

Christian FRIEDRICH², Frederik REICHERT³

¹Porsche AG, Stuttgart, Germany EU,

²Hochschule Karlsruhe – University of Applied Sciences, Karlsruhe, Germany, Stuttgart, Germany, EU

³Hochschule Esslingen, Esslingen, Germany

EVALUATION OF ARTIFICIAL INTELLIGENCE METHODS FOR LEAD TIME PREDICTION IN NON-CYCLED AREAS OF AUTOMOTIVE PRODUCTION

Abstract

The present study examines the effectiveness of applying artificial intelligence methods in an automotive production environment to predict unknown lead times in a non-cycle-controlled production area. Data structures are analysed to identify contextual features and then pre-processed using one-hot encoding. Methods selection focuses on supervised and unsupervised machine learning techniques. Results show that in unsupervised learning, the kMeans algo-rithm can identify patterns in the data, but these patterns do not correlate with the use case. In supervised learning, regression and classification methods are evaluated. Continuous regres-sion based on target size distribution is not feasible. Classification methods analysis shows that Ensemble Learning and Support Vector Machines are the most suitable. Preliminary study results indicate that gradient boosting algorithms LightGBM, XGBoost, and CatBoost yield the best results. After further testing and extensive hyperparameter optimization, the fi-nal method choice is the LightGBM algorithm. Depending on feature availability and predic-tion interval granularity, relative prediction accuracies of up to 90% can

be achieved. Further tests highlight the importance of periodic retraining of AI models to accurately represent complex production processes using the database. The research demonstrates that AI methods can be effectively applied to highly variable production data, adding business value by providing an additional metric for various control tasks while outperforming current non AI-based systems.

David HOLMAN, Venuše DOLEJŠOVÁ, Dalibor FIBIŠ
Škoda Auto University, Mladá Boleslav, Czech Republic, EU

PURPOSEFUL MINDSET ENHANCED BY ON-LINE IT SOLUTION FOR LONG TERM COMPETITIVE ADVANTAGE IN THE AUTOMOTIVE SUPPLY CHAIN

Abstract

The foundation of competitive advantage in the 20th century was largely predicated on know-how, allowing organizations to sustain an edge through specialized expertise and proprietary competencies. However, the 21st-century global context, defined by unprecedented interconnectedness and rapid technological dissemination, has rendered know-how widely accessible and insufficient for maintaining a competitive position. While traditional reactive approaches supported by Maximization mindset and robust IT infrastructures, such as Enterprise Resource Planning (ERP) systems, have evolved to incorporate know-why capabilities for enhanced analysis and strategic forecasting, these advancements remain inadequate for securing sustained competitive advantage, particularly when accounting for the environmental and social imperatives of sustainable development. Achieving and sustaining competitiveness in the 21st century necessitates a shift from a reactive framework to a proactive paradigm underpinned by Understanding of Wholeness. This advanced intellectual capacity surpasses the earlier construct of holistic understanding by enabling organizations to effectively manage complex and evolving challenges. A proactive, Purposeful mindset based on Wholeness Systems Thinking cultivates adaptability, fostering processes that are not only efficient for current operational needs but are effective for strategic continuous adaptation and evolution. These processes can be augmented through advanced IT solution such as Integrated Kanban System (IKS), which embody this proactive philosophy by facilitating the seamless and value-centric flow of operations across globally interconnected networks. A specific application of Understanding of Wholeness supported by IKS in the automotive supply chain will be presented and described.

Agnieszka JAGODA, Anna BARANIECKA, Joanna ŁYSZKIEWICZ POTACZEK
Wroclaw University of Economics and Business, Wroclaw, Poland, EU

MANAGEMENT'S GREEN MOTIVATION IN SUPPLY CHAIN MANAGEMENT – A CASE STUDY OF GREEN SUPPLY CHAIN

Abstract

In the article, an analysis was conducted on the motivation of management in making pro-ecological decisions in supply chain management, using the example of Sikla Polska. The study emphasizes the difference between green internal motivation and external motivation among the management team. Internal motivation arises from personal beliefs and concern for the environment, while external motivation responds to legal regulations, customer requirements, and competitive pressure. Understanding the motivation of the management team is crucial for the effective implementation of green supply chain management.

Peter KAČMÁRY, Simona ŠPIRKOVÁ, Kristína KLEINOVÁ, Maroš MESAROŠ

Technical University of Košice, Košice, Slovakia, EU

DEVELOPMENT OF PUBLIC TRANSPORT USE IN SELECTED CITIES WITHIN SLOVAKIA

Abstract

The structure of a transport system in larger cities is crucial for the fast and efficient movement of goods and people. In cities, public transport tends to be problematic and is overwhelmingly represented by the individual car transport. It is the endeavour of every city to operate public transport in a way that encourages people not to use their own cars. This paper is focused on the analysis and prediction of public transport use in selected cities in Slovakia. The analysis enters data of annual values for the last 10 years. The prediction involves a combined forecasting approach, which is the result of merging the four methods described in the paper.

Marek KARKULA^{1,2}, Dariusz OLEARCZUK², Rafał SZCZUR²

¹AGH University of Krakow, Krakow, Poland, EU

²Optidata Sp. z o.o., Krakow, Poland EU

TRANSFORMING TRANSPORT MANAGEMENT WITH AI AND IT

Abstract

Presented paper examines how Artificial Intelligence (AI) and Information Technology (IT) are transforming the way companies manage distribution and deliveries. By utilizing AI techniques like machine learning and deep learning, businesses can significantly improve their delivery routes, anticipate changes in demand, and streamline their overall logistics operations. This involves analyzing real-time traffic, dynamically adjusting delivery paths, and optimizing how vehicles are loaded to minimize delivery time and costs. The research delves into specific AI applications, such as adjusting routes on-the-fly in response to traffic, weather, and unforeseen events. The study also addresses the challenges of implementing IT and AI solutions in the transportation sector, including data quality and privacy concerns, cybersecurity risks, and the need for a skilled workforce.

Kristína KLEINOVÁ, Peter KAČMÁRY, Martin STRAKA

Technical University of Kosice, Košice, Slovakia, EU

ARTIFICIAL INTELLIGENCE IN LOGISTICS: NEW OPPORTUNITIES FOR OPTIMIZATION AND INNOVATION WITH CHATGPT

Abstract

This article explores the potential of utilizing artificial intelligence to streamline processes in the logistics sector, which currently faces numerous challenges, including the need to enhance logistics procedures. With the rising demand for more efficient and flexible supply chains, artificial intelligence is crucial for improving demand forecasting, route optimization, inventory planning, and warehouse operations management. The goal is to initiate a discussion on the application possibilities of the ChatGPT model in logistics, emphasizing the benefits of this advanced technology - from faster calculations and flexible responses to changing market conditions to the ability to process and analyze large volumes of data in real time. The article's primary aim is to highlight that integrating ChatGPT into logistics systems could significantly boost efficiency and sustainability in logistics operations. However, it is essential to remember that the ChatGPT model may contain errors and inaccuracies,

underscoring the importance of subsequent verification of its outputs. Implementing ChatGPT could bring comprehensive solutions to complex logistics operations and create new opportunities for innovation and transformation in this sector, thus supporting performance improvement and economic efficiency.

Tomasz KOŁAKOWSKI, Agnieszka JAGODA, Magdalena MUCOWSKA, Katarzyna CHEBA

Wroclaw University of Economics and Business, Jelenia Góra, Poland, EU
West Pomeranian University of Technology, Szczecin, Poland EU

**PRO-ENVIRONMENTAL BEHAVIOR FACTORS IN CHOOSING
THE LAST MILE DELIVERY METHOD. A GENDER PERSPECTIVE**

Abstract

In the last few years e-commerce market has increased in population shares but the situation has changed dramatically since the Covid-19 pandemic. Electronic marketplaces have changed due to rapid digitalization and shopping. Online services offer the possibility to choose a different delivery method such as home delivery or out-of-home delivery. This aspect of the e-commerce market faces an increased interest among practitioners and academia in the field of sustainable last mile deliveries. Interestingly, the subject literature consists of papers analyzing the e-commerce impact on the last mile delivery. However, the identification of factors for choosing a delivery method and factors that motivate e-customers to choose an eco-friendly delivery method is still an unrecognized field of research. Thus, the main purpose of the paper is to compare factors among the gender that motivate e-customers for choosing a delivery method. The research was conducted among 1,110 e-customers in Poland in 2021. The paper aims to answer the following research question: what factors motivate each gender for choosing a delivery method?

Jakub KOVALČÍK, Martin STRAKA, Peter KAČMÁRY

Technical University of Košice, Košice, Slovakia, EU

**SPECIFIC METHODOLOGY FOR MODELING A LOGISTIC SYSTEM
USING AN EDUCATIONAL ROBOT**

Abstract

Current approaches to designing logistic systems are not directly oriented toward the use of educational robots, creating a need for a new methodology that effectively integrates these tools. The main objective of this work is to present the possibility of creating a specific model of a robotized workplace in a laboratory setting, where educational robots are used as small physical models to simulate logistic flows and workflows. This model accurately represents elements commonly found in industrial logistics operations and offers a practical demonstration of automated logistic processes. The significance of this methodology also lies in its application in accredited study programs focused on industrial logistics, where it enhances training and understanding of real-world applications in logistics and automation.

Marzena KRAMARZ

Silesian University of Technology, Gliwice, Poland, EU

RESILIENCE OF THE CITY'S LOGISTICS SYSTEM TO DISRUPTIONS

Abstract

Changes in cities that allow them to be called smart require adapting logistics solutions to new challenges. Smart cities take care of all stakeholders and strive to improve the quality of life. One of the factors that affect quality of life is a city's resilience to disruption. The purpose of this article is to point out the importance of the resilience of a city's logistics system in the pursuit of raising the quality of life while taking into account the needs of the various stakeholders of the city's flows.

**Roger KSIĄŻEK, Katarzyna GDOWSKA, Radosław KAPŁAN,
Magdalena DUDEK, Andrzej RAŻNIAK**

AGH University of Krakow, Krakow, Poland, EU

HYDROGEN REFUELLING STATION LOCATION PROBLEM IN THE RAILWAY SYSTEM – PRELIMINARY STUDY

Abstract

The location of infrastructure facilities is a critical long-term decision in various sectors, such as production, logistics, and military. This decision becomes especially vital when implementing new technologies that can significantly impact industries or economies. This paper focuses on the integration of hydrogen propulsion technology into rail transportation, where the fixed infrastructure and limited flexibility of the track network make the placement of hydrogen refueling stations (HRS) crucial for the development of hydrogen energy and fuel cell technology. To address the hydrogen refueling station location problem, we adopt a model inspired by the Economic Order Quantity (EOQ) model. The approach integrates various factors such as fuel demand, hydrogen availability, and infrastructure costs into the optimization process. The model employs mathematical tools, including Mixed-Integer Programming (MIP), to identify optimal station locations based on selected decision criteria, enabling scenario-based analysis. The developed model considers both single-period and multi-period problems to account for factors such as anticipated demand changes and fluctuating hydrogen production costs. This paper presents a newly developed Hydrogen Refuelling Station Location Problem for Railways (HRSLPR), formulated as a simplified single-period problem. A corresponding Mixed-Integer Linear Programming (MILP) model is developed, and the approach is outlined. The model is intended to support decision-makers in evaluating the impact of various parameters on strategic planning for hydrogen infrastructure deployment, contributing to the efficient integration of hydrogen propulsion in rail networks.

Radim LENORT, Pavel WICHER

Škoda Auto University, Mladá Boleslav, Czech Republic, EU

SUPPLY CHAIN MANAGEMENT AND LOGISTICS MEGATRENDS: A LITERATURE REVIEW

Abstract

In the rapidly evolving global market, supply chain management and logistics play a critical role in ensuring the efficient flow of goods, information, and resources. This paper presents a comprehensive literature review focused on the megatrends shaping the future of supply chain management and logistics. In an era marked by unprecedented technological advancements and global disruptions, understanding these megatrends is crucial for both academic researchers and industry practitioners. The review synthesizes findings from a wide array of scholarly articles and industrial studies, identifying and classifying key supply chain management and logistics megatrends. The findings underscore the transformative potential of these megatrends and the need for proactive adaptation to maintain robustness and sustainability in supply chain and logistics operations.

Tomáš MALČIČ¹, Jiří ZÁRUBA²

¹Škoda Auto University, Mladá Boleslav, Czech Republic, EU

²VSB – Technical University of Ostrava, Ostrava, Czech Republic, EU

IMPLEMENTATION OF UNIT LOAD AGV TECHNOLOGY IN STREAMLINING OF THE IN-HOUSE LOGISTICS OF AN AUTOMOTIVE ASSEMBLY HALL

Abstract

The automotive industry is currently undergoing a significant transformation due to 4th industrial revolution. The importance of effective implementation of advanced technological solutions in manufacturing and logistics processes is increasing due to a number of factors, including globalisation, competitiveness, product customisation, shortage of qualified workforce and overall SCM complexity. In order to overcome these challenges, it is essential that logistics systems are being continuously improved and innovated in the automotive industry. The implementation of automated guided vehicles (AGVs) represents a pivotal technology in the automation of production logistics processes. Similarly to the automotive industry as a whole, AGV technology is subject to constant evolution and improvement as well. The aim of this paper is to present the advantages and benefits of implementing a new generation of advanced unit load AGVs within a case study of the streamlining of assembly line supply processes in the automotive industry. The case study will analyse the original supply process system, which was based on tow AGV units with a central charging station. The original technological solution will be analysed, with focus on the identification of shortcomings of the system. Subsequently, a new system for automatic assembly line supply that is based on the implementation of unit load AGVs will be presented. The contribution of new technological functionalities, including automatic loading/unloading, optimisation of supply routes, flexible charging modes and more advanced navigation, will be emphasised. Finally, a future vision of the assembly line supply system will be presented, which will fully utilize the potential of the implemented technology.

Robert MAZUR

PPUH AUTOPART Jacek Bąk Sp. z o.o., Mielec, Poland, EU

**THE DIGITAL MATURITY LEVEL OF EAST AUTOMOTIVE ALLIANCE MEMBERS –
RESULTS AND CHALLENGES IN IMPLEMENTING DIGITAL INNOVATIONS IN SUPPLY CHAINS**

Abstract

Paper explores the digital maturity of member organizations within the East Automotive Alliance (EAA) and examines the challenges and opportunities presented by implementing digital innovations in supply chains. By employing the Digital Maturity Assessment (DMA) framework, the study evaluates the digital transformation capabilities of EAA firms, identifying strengths in data management, human-centric digitization, and transparency, as well as challenges such as inconsistent digital strategies, talent shortages, and legacy infrastructure integration. The research underscores the importance of an integrated digital strategy as a foundation for effective transformation and highlights the collaborative potential within the alliance for cost-effective and accelerated digitization. The findings emphasize that digital transformation is an ongoing process requiring adaptability and innovation, with increasing relevance of AI technologies in streamlining operations and enhancing competitiveness.

Patricia MUCHOVÁ, Marek ONDOV

Technical University of Košice, Košice, Slovakia, EU

OPERATIONAL TRANSPORT PLANNING USING A HEURISTIC APPROACH

Abstract

The paper refers to the characteristics of using a heuristic approach and characterizes heuristic analysis for designing an effective method of optimizing transport planning to ensure cost-effective solutions under time-constrained conditions. The heuristic model is structured to provide acceptable solutions in cases where optimal solutions are computationally demanding or when precise data is unavailable. The criteria for creating the heuristic model outlined in the paper enable dynamic decision-making and adaptation in operational planning, ensuring flexibility in response to changing transport conditions. The proposed approach delivers rapid, practical solutions to operational challenges in transport. The heuristics implemented in the model are particularly useful when precise optimization solutions are not practically attainable and where finding the optimal solution can be computationally intensive or time-inefficient. By applying the heuristic model to operational transport management, overall transport costs can be minimized. More importantly, the model enhances the efficiency of the entire transport system, demonstrating the systemic impact of the heuristic approach. The article focuses on clarifying the creation of the heuristic model and its subsequent application to a problem within the scope of operational transport planning. The study's primary goal is to understand the heuristic approach in logistics comprehensively. Additionally, it aims to support future work by other researchers and fill research gaps by highlighting the importance of applying a heuristic approach to specific issues in the transport process.

Marek ONDOV, Andrea ROSOVA, Marian SOFRANKO, Lukas HORIZRAL

Technical University of Kosice, Kosice, Slovakia, EU

MODELLING HUMAN INTERACTION WITH A LOGISTIC SYSTEM

Abstract

Logistic systems are an indispensable part of businesses across various industries. Despite current trends of robotization and automation in logistics, one of the main elements of logistic systems remains people – the workers. It is precisely the workers, through their constant interaction with the system, who understand it best. Over time, they develop improved processes that facilitate their interaction with the system – and thus their work. A simulation-based approach is commonly used to improve logistics processes. System modelling and subsequent simulations with cost-free parameter adjustments are effective tools for identifying improvements within the system. However, modelling logistic systems must not overlook the interaction and interventions of workers in the system. Modelling this interaction is essential if the model reflects the actual system. Modelling human behaviour is complex and must consider various factors, distinguishing between effective system improvements and inefficient attempts. The process of modelling human interaction with logistic systems, based on modelling elements and heuristics, is presented through an example from the mining environment – specifically, the interaction of workers with the mining transport system. Modelling worker interactions with the transport system produced a set of rules and processes that improve the system's performance or ensure the safety of system components. In subsequent simulations and the design of effective improvements, time can be saved as some basic improvement proposals are already implemented in the model according to worker interaction with the system.

Honorata POTURAJ

Wrocław University of Science and Technology, Wrocław, Poland, EU

CAUSE-EFFECT ANALYSES IN THE OPERATION OF AGV SYSTEMS

Abstract

This research applied cause-effect analysis to enhance the operation of an Automated Guided Vehicles (AGV) system. AGVs, widely used for internal transport, follow preprogrammed routes and perform repetitive tasks. However, AGV still require continuous monitoring due to potential adverse events. Adverse events in AGV systems can be caused by unexpected conditions, failures, or a lack of information. Response to only these events is insufficient. It is crucial to analyze both causes and effects to improve the system and mitigate future adverse events. The research focused on analyzing the causes and effects of an adverse event in an AGV system used in an automotive company. Two methods were applied: the Ishikawa diagram and Bow Tie analysis. Data were collected from employee interviews, the AGV system database, and technical reports. The Ishikawa diagram helped identify the detailed causes of the adverse event and highlighted potential risks that could lead to its recurrence. Bow Tie analysis also provided insights into the event's effects. Bow Tie analysis, combined with the Ishikawa diagram, gave a thorough understanding of the consequences of the event, with a focus on AGV operation. The study identified controls and actions that could be implemented to prevent similar issues. This approach allows for both corrective and preventive actions and can be applied to other logistics systems, which use automated transport solutions, leading to improved efficiency and reduced risk.

**Rafał RUMIN, Dawid PEKAŁA, Mateusz MILCZANOWSKI,
Klaudiusz MENDREK, Szymon GACH**

Akademia Górniczo-Hutnicza im. Stanisława Staszica w Krakowie, Kraków, Poland, EU

**SOCIOECONOMIC ASPECTS OF HYPERLOOP DEVELOPMENT BASED
ON THE CENTRAL COMMUNICATION PORT (CPK)**

Abstract

Socioeconomic aspects of Hyperloop Development based on the Central Communication Port (CPK). This paper examines the socioeconomic implications of implementing Hyperloop technology in Poland, focusing on its integration with the Central Communication Port (CPK). The development of Hyperloop, a high-speed vacuum train system, offers transformative potential for long-distance transportation by significantly reducing travel times, enhancing logistics, and promoting energy efficiency. This paper explores the design, and simulation of the Hyperloop stations tailored to Polish transport infrastructure. Simulations conducted in FlexSim software demonstrate the potential of Hyperloop stations to streamline passenger flow, logistics, and safety protocols.

Rafał RUMIN¹, Olena STRYHUNIVSKA¹, Olena PALIENKO²

¹Akademia Górniczo-Hutnicza im. Stanisława Staszica w Krakowie, Kraków, Poland, EU,

²State University of Trade and Economics; Korpus A, Vulytsya Kioto, 19, Kyiv, Ukraina, 02156

**THE MANAGEMENT OF THE TECHNOLOGICAL PROCESS ACCORDING TO THE PRODUCT
LIFECYCLE AND CIRCULAR ECONOMY CONCEPT**

Abstract

This study examines strategies for integrating life cycle management with circular economy principles to minimize waste and maintain product quality. Key stages of the product life cycle, from design and production to use and recycling phases, are analyzed, and methods for managing these phases to ensure production quality and promote resource efficiency are discussed. Additionally, this research explores technological advancements and process innovations that support the circular economy, including resource-efficient design and readiness for circularity.

Mateusz RYDLEWSKI, Szymon CZAPKOWSKI

Wrocław University of Science and Technology, Wrocław, Poland, EU

TRANSPORT PACKAGING IN THE CARGO BIKE DELIVERY SECTOR

Abstract

Cargo bikes are specialist vehicles structurally similar to bicycles, but equipped with a cargo space that enables the transportation of goods in densely populated urban areas. Primarily used for short-distance deliveries, and they are an environmentally friendly alternative to traditional delivery vehicles, especially in the case of delivering food, parcels and small goods in city centres. Due to the growing popularity of their use and plans to implement such systems in the country, the aspect of transport packaging used in this delivery sector was analysed. The article discusses the issue of transport packaging, analyses the design solutions of delivery bikes available on the Polish market and compares them with each other. In addition, based on the legal conditions applicable in the delivery sector for transport packaging, they were verified in terms of the possibility of their use in bicycle deliveries. The discussed topic also included the initial results of research conducted among recipients of goods in the strict centre of one of the Polish cities. The target group selected in the study consisted of business owners, mainly from the HORECA group, for whom goods can potentially be delivered using cargo bikes. The analysis of the data collected in this way allowed for the drawing of conclusions on the development of the indicated area, the determination of actions necessary to improve the logistics system in the bicycle delivery sector and the challenges posed to the packaging of shipments delivered using this type of vehicles.

Jakub SEMRAU

Silesian University of Technology, Zabrze, Poland, EU

INNOVATIVE APPLICATIONS OF RENEWABLE ENERGY SOURCES IN THE CONSTRUCTION SECTOR – A REVIEW OF CURRENT PRACTICES

Abstract

This article provides an overview of current applications of renewable energy sources (RES) in the construction sector, highlighting recent innovations that address environmental and energy efficiency challenges. The review focuses on the integration of technologies such as solar panels, wind energy systems, and geothermal solutions within building projects. It discusses the impact of these technologies on energy consumption, cost reduction, and carbon footprint. By examining real-world implementations and advancements, this article underscores the growing role of RES in promoting sustainable construction practices and meeting regulatory standards for greener building solutions.

Emilia SKUPIEŃ

Wrocław University of Science and Technology, Wrocław, Poland, EU

MATURITY MODEL FOR TRANSPORT SYSTEM ASSESSMENT

Abstract

Transport systems consist of various subsystems, including technical, organisational, financial, and regulatory aspects. Assessing these systems, even divided into individual branches, does not make it easy because of different operational conditions related to geographical, economic, and administrative factors. The literature studies on the transport system indicate that the most frequently assessed groups of factors are transport, economic, safety, social, political, business environment, and natural environmental factors. The dominant role of assessing transport systems play Multi-Criteria Decision Making methods. On this basis, the maturity model was proposed as a helpful tool for comparisons and also for determining the development directions of transport systems. This article presents a brief review of the assessment methods and the assessed parameters of transport systems. On the basis of which, the maturity model for transport systems was proposed. The presented transport system maturity model assumes taking into account the main groups of parameters influencing the efficiency of the system, containing system elements (infrastructure, fleet, transport process service), presented at five maturity levels. The model was built in a way that allows its adaptation to various branches of transport (road, rail, sea, inland water, and air) and provides for the assessment of the system status, comparison with other systems and setting recommendations for the development of individual elements in order to achieve a higher level of transport system maturity. Due to the dynamic development of digital tools, special attention was paid to the use of digitisation in the functioning of the system.

Simona ŠPIRKOVÁ, Martin STRAKA, Jakub KOVALČÍK

Institute of Logistics and Transportation, Košice, Slovakia, EU

ENHANCING MANUFACTURING LOGISTICS EFFICIENCY THROUGH 3D SIMULATION IN VISUAL COMPONENTS

Abstract

The increasing complexity of manufacturing logistics demands innovative solutions to optimize workflows, reduce costs, and improve efficiency. Visual Components, a 3D simulation software, has emerged as a powerful tool for visualizing and refining logistics operations within manufacturing environments. This article explores the use of Visual Components for simulating logistics workflows, focusing on its capacity to model complex systems like conveyor networks and robotic handling. Through practical applications and case studies, we examine how this software enables manufacturers to virtually test and optimize layouts, streamline material flows, and predict bottlenecks before physical implementation. The benefits of 3D simulation, including enhanced collaboration, reduced design errors, and data-driven decision-making, underscore its value in logistics optimization. We also discuss future trends, such as the integration of AI and digital twins, which are set to further transform the role of 3D simulation in manufacturing logistics.

Agnieszka TUBIS

Wrocław University of Science and Technology, Wrocław, Poland, EU

COMPARATIVE ANALYSIS OF FASHION AND MILITARY CLOTHING SUPPLY CHAINS

Abstract

Publications on the management of apparel supply chains focus primarily on the organisation of a fast, flexible and reliable supply of materials and finished goods at subsequent stages of processing and distribution. A critical issue is implementing the concept of 'rapid response', which, based on the information integration of partners, allows a rapid response to changing market demand for finished goods. This is mainly due to the clothing market's specifics and customers' consumption behaviour, who react impulsively to fashion novelties. The supply chains responsible for supplying military clothing are quite different. The specifics of customer behaviour and the relationships established by links in military clothing supply chains do not require implementing solutions using Quick Response concepts. However, these chains report a demand for improvements to current material flow control systems, which should consider their safety, comfort, protection and performance requirements. This article aims to provide a comparative analysis of traditional (fashion) and military apparel supply chains. The analysis aims to identify the common features of both systems and the differences flowing out of the different material flow management systems in the chain. The research used a narrative literature review method and a case study of a selected supply chain serving the military apparel market. The results make it possible to identify the potential for improving cooperation mechanisms in military clothing supply chains and to set further directions for ongoing research.

Sylwia WERBIŃSKA-WOJCIECHOWSKA, Robert GIEL, Natalia GNACY

Wrocław University of Science and Technology, Wrocław, Poland, EU

THE ROLE OF DIGITAL MATURITY IN IMPROVING SAFETY AND RELIABILITY IN WOOD-BASED SUPPLY CHAINS – CASE STUDY

Abstract

The need for digital transformation is arising from increasing expectations from various interested parties that place different requirements on the supply chain, like ensuring the availability of products or raw materials. This trend can also be observable in the forestry and wood-based industries. Therefore, the article focuses on the issues of the definition of digital maturity in a supply chain from the wood-based industry with particular importance of safety and reliability issues. Digital transformation signifies changes in all supply chain components and systems by replacing traditional practices with new ones based on digital solutions. It gives the possibility to improve operational efficiency and effectiveness as well as to decrease operational risk in the chain. Therefore, the main problem addressed in the paper is investigating the possibility of building digital maturity in a selected company operating in a wood-based supply chain. Indeed, the paper presents a short literature review on the defined research area. Later, the wood-based supply chain's main operational problems are characterized. Based on this, the digital maturity short analysis for the case company is investigated. The work ends with conclusions and directions for further research.