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ABSTRACTS

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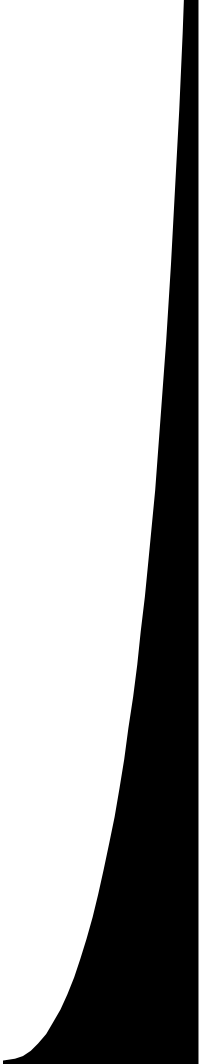
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Plenary



DIGITAL TWINS FOR CCAM APPLICATIONS - THE CASE OF AUGMENTED CCAM AND BEYOND

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Keywords: digital twins, connected cooperative and automated mobility, infrastructure support, physical, digital and communication infrastructure, operational design domain

In an increasingly more digitized world, Digital Twins (DT), standing for the virtual replication of physical counterparts being assets – objects and/or systems and/or processes, seem to be also increasingly gaining a dominating place in a series of industries (automotive and transport, manufacturing, smart cities, healthcare and construction). Companies that have implemented them have seen an average increase of 15% in efficiency and a 13% reduction in maintenance costs (Burak, 2023), while according to MARKETSSANDMARKETS, the DT market is predicted to grow from \$3.5 billion in 2020 to \$73.5 billion by 2027, with their applications in automotive and transport industries accounting for the largest share of the market. Some of their recognised advantages encompass enabling predictive maintenance and decision making, fostering of collaboration among teams and potential to improve customer service; still there are challenges to be confronted, such as data integration and management, related to the accuracy and mining of data originating from multiple sensorial sources, DT complexity and scalability as well as security and privacy concerns.

DT in automotive and transport industries, have been created for design, construction and life-cycle management of different assets, such as bridges and roads, while Industry 4.0. OEMs, such as Tesla, BMW and Toyota are seeing in them the future of transportation. Tesla produces a DT for every car it sells while Toyota is building a connected prototype “Woven City” at the base of Mt. Fuji in Japan. In New South Wales (NSW), Australia, a real-time DT ecosystem is being developed through a multitude of projects and in China, cities like Beijing and Shanghai, are creating DT of their transport network to improve real-time efficiency through 51WORLD suite of products.

In specific for Connected Cooperative and Automated Mobility (CCAM), DT are applied primarily for prediction, assessment and decision-making purposes aiming to optimise novel, under-validated paradigms prior to their deployment and towards the increase of traffic safety and efficiency, counterbalancing costs and unpredicted side effects. Given the vast spectrum of data sources from the vehicles, the infrastructure, other connected users and the communication and digital enablers of short and long-range telecommunication, data integration and their scalability - directly associated with costs - constitute the key challenges. Depending the DT context and purpose - i.e. study of driving/ vehicle behaviour and interaction with traffic participants on microscopic driving level vs the study of new CCAM services design and impacts on macroscopic / network level - requirements for development and use differ substantially. In addition, most of the applications so far are not developed for bilateral real-time operational response which is essential to CCAM, where the DT, to be worth investing, needs to be an accurate representation of the cyber-physical system (CPS) and to replicate, apart from the static physical environment and its attributes, real time operation of different generation of connected and automated vehicles,

that involves V2X and I2V communications, 4G and 5G networks, IoT devices, cloud services, stakeholders, etc. Bidirectional exchange between the digital and the physical world is required to turn the DT to an active system of the transport ecosystem, which goes beyond off-line assessment purposes, and is expected to feed in real time High Definition maps and other third-party services.

The current manuscript will present the new revised taxonomy and incremental anticipated support of DT for CCAM, that will be part of a holistic PDI (Physical, Digital and Communication) support classification schema aimed by the AUGMENTED CCAM EU funded Innovation Action, and will additionally present the objectives, requirements and development approach for the DT that will be developed for and will run in parallel with the project’s seven physical sites in France, Latvia and Spain, that include test tracks, depots, living labs and open traffic urban, rural and highway areas. Eleven novel PDI support solutions, varying from minimum risk manoeuvres to logistics and dynamic traffic management services for CCAM, will be deployed in them aiming to extend the Operational Design Domain (ODD) of automated vehicles and the functionality of all other vehicle cohorts (connected, cooperative, conventional) under mixed operation conditions. The DTs will aim to validate the new PDI solutions impacts in addition to the field trials validation and in synergy with validation activities in AV and driving simulators as well as microscopic and macroscopic traffic simulations, and, by this, constitute a best practices ground in DT for CCAM.

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DIGITAL TWIN AS A TOOL FOR PROJECT DEVELOPMENT

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Keywords: digital twin, simulation, manufacturing, production, digitalization, cargotube, logistics

Today, the "digital twin" is an important tool in industry for controlling and optimizing processes, production facilities and entire factories. Automation and digitalization form the basis of this digital transformation. With the digital twin, it is also possible to estimate future scenarios. The digital twin can already be used for small projects or for assembly production. These individual solutions can be combined so that the simulation of complex systems is also possible. The first prerequisite is that the relevant data that significantly influence the process are recorded and displayed. However, too much detailing of the systems and the input variables would unnecessarily increase the workload.

Since the visualization of processes creates a good understanding for the user, a variety of software solutions are used today. For example, offline programming is used to plan and control the production steps. A digital image of the hardware of the production equipment is created and the product is manufactured virtually. For example, when welding an assembly, all process steps within a production cell with a robot in a 2D or 3D application are traversed step by step and relevant process parameters are defined. Robot movements, the closing and opening of clamping devices, the control of the welding units are generated independently by the software and the complete production sequence can be simulated. This then results in the required process times and the user can make optimizations in order to manufacture a technically perfect product under economic aspects. Required semi-finished products and auxiliary materials can be extracted and the technical connected loads can be estimated. This data is then fed into the higher-level process planning and control system. The production unit under consideration can then be transferred to the factory layout, so that in the end a digital twin is created, with which connected processes can be represented. Real processes are simulated and further optimized. If changes become necessary, e.g. due to external disturbances or optimisation requirements, these can then first be processed virtually without having to intervene in ongoing real production processes.

The findings from production can also be adopted for transport systems. In transport logistics, the automation of handling processes and picking for deliveries (JIT and JIS) will play an even greater role in the future. New logistics concepts such as CargoTube are being developed with the help of the digital twin, among others, to determine the potentials of climate-neutral transport of goods in low-pressure tubes. The supply security of a production location through an externally positioned logistics hub as well as the performance of CargoTube applications within logistics networks are being addressed in initial studies. The essential success factor from today's point of view is the automated loading and unloading of vehicles in the logistics hubs as well as the required switch technology for the pods between tube and hub to achieve high cycle times.

In CargoTube a Robotic Smart Packing/Loading Simulator will be used to develop and understanding of how these technologies support the end-to-end cargo flow in fast moving logistics operations. A digital twin enables to test algorithms, design robots, perform regression testing, and train AI system using realistic scenarios. Populations of robots can be simulated in complex indoor and outdoor environments, using a robust physics engine and powerful high-quality graphics.

New and innovative technologies in particular require visualization and need a large number of variations of the technologies used in order to be able to offer a marketable product at the end of the development process. Here, the digital twin can provide significant amounts of knowledge and is more than just a simulation software of process steps to determine individual KPIs.

HUMAN DIGITAL TWIN FOR COMFORT EXPERIENCE IN AVIATION

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Keywords: human digital twin, comfort, aviation

The comfort experience can influence passengers' choice of airlines, especially for business travelers (Anjani *et al.*, 2021). While the product/service/environment itself cannot be comfortable, the user speaks during and after the use of it (Mansfield *et al.*, 2020). Vink & Hallbeck summarized that comfort can be interpreted as “a pleasant state or relaxed feeling of a human being in reaction to its environment” and discomfort as “an unpleasant state of the human body in reaction to its physical environment” (Vink & Hallbeck, 2012).

While the word (dis)comfort offers a nice cosmetic coating of the phenomenon, it has many constructs (Mansfield *et al.*, 2020). These constructs are associated with the users' backgrounds, their expectation(s), the (social) environment(s), the product(s) they are using, the interactions between the users and the product/environment, and the duration of use (Naddeo, 2017; Song & Vink, 2021). Although many factors that may influence the comfort experience of passengers were discussed in the literature, constructing a comfort model for an individual remains a challenge due to the complexity of the environment and the differences among individuals (Song *et al.*, 2023).

Advancements in technology enable real-time modeling for both cabins and passengers based on the concepts of Digital Twins (DT) and Human Digital Twins (HDT). The DT involves creating a meaningful and updatable temporal model, which serves as a digital replica of the physical object (Fuller *et al.*, 2020). On the other hand, an HDT represent a (temporal) digital replica of an individual, encompassing their characteristics across different aspects and for various tasks within different contexts. HDTs are personal, private, multidimensional, updateable, context-sensitive, descriptive, predictive, mobile, robust, interactive, and integrable. However, it is important to note that certain models in HDT might entail large uncertainties.

In the architecture proposed by Song (Song, 2023), the HDT is established on a data lake housing human-related data. This data lake serves as a valuable resource for constructing various human population models, all of which are stored within a model and interface library. An HDT can access predefined models through their interface and then personalize the acquired model(s) using newly obtained personal data and machine learning algorithms, such as transfer learning. Different elements in an HDT are facilitated by a set of key enabling technologies, including human modeling, IoT, data security, wearables, minimum viable sensing, (explainable) AI, data visualization, and extended reality (XR).

While HDT has been applied in personalized medicine, smart city, manufacturing, sports, the metaverse, and personalized products, it is also introduced to mobility. In the European project COMFDEMO, researchers set out to construct HDTs of passengers to predict their comfort and discomfort experiences during flight. Two flights were organized at Rotterdam Airport, employing an ATR72-500 turboprop. A total of 97 passengers participated in the flights, with 40 of them chosen to wear specialized jackets integrated with measurement tools. Data was collected, analyzed, and utilized to create an updatable model of each HDT, enabling the estimation of passengers' comfort and discomfort based on 33 factors. The project outcomes demonstrated that HDT can predict comfort levels, although with some uncertainties. Additionally, the study highlighted factors such as row, hip-width, time, popliteal height, gender, and age play pivotal roles in influencing the comfort and discomfort experience of passengers.

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Smart Solutions in Transport Systems

ANALYSING DISTRIBUTION APPROACHES FOR EFFICIENT URBAN LOGISTICS

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Keywords: urban logistics, last-mile logistics, distribution scenarios, optimization algorithm

Urban logistics plays a crucial role in modern society by covering all the flows of goods and services in such a complicated transportation network. Despite the huge number of studies highlighting the relevant influence of last-mile logistics, this stage is still described as a crucial problem in the supply chain. Only a few have used real-world data to study the relationship between logistic distribution paradigm and supply. This study aims to compare different distribution scenarios using the aggregation of stops by grouping entities, for instance, the postal code approach (PCA) and the volume-based approach (VBA) to indicate the most effective one in simplifying urban logistic operations. These two scenarios illustrate two aggregation criteria: geographical, which cluster stops with those closest ones, and non-geographical, which tends to cluster stops with similar stops. Used stops came from a real-world dataset acquired from urban logistics operators in the East of Rome. In this study, an optimization algorithm called ADARTW is used to build up vehicle tours through the sequential insertion of customers based on a nonlinear objective function that creates a sequence of stops. A comparison between those two approaches has been done to illustrate the similarities and differences in terms of CO2 emissions, travel length, and delivery time; moreover, the unloading times as an indicator of road congestion and drivers' performance, have been studied. Preliminary results have shown that VBA leads to a more even distribution of delivery time in busier areas while PCA has more non-uniform distribution; additionally, VBA has shorter average delivery times for each stop. Furthermore, PCA is affected by the demand level which may be varied within the areas while the VBA may solve this issue. The outcome could have the potential for companies and researchers interested in urban logistics due to the proposal of a new way of making distributions, real-world data usage, and comparing different scenarios.

ELECTRIC KICK SCOOTER DRIVING SIMULATION - RISKS AND SAFETY

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Keywords: electric kick scooter, vertical dynamics, computer simulation, risk and safety

Micro-mobility is currently a significant global trend in city transport innovation, with introduction of electric kick scooters representing a major breakthrough. However, these mobility systems have resulted in numerous accidents, primarily due to incorrect usage and insufficient safety measures (Lee *et al.*, 2021). Given that kick e-scooters are a relatively new type of vehicle, established mathematical models are still in development. Developing a model could be beneficial in comprehending the dynamic properties of these micro-mobility vehicles, which could ultimately enhance their design and reduce the incidence of riding accidents. The computer simulations are speed up design and reduce the risks and costs associated with experimental testing is a widely accepted technique in the transport industry. The simulation process in motorcycles, scooters etc. (two wheels vehicle) is more challenging compared to cars (four wheels vehicle) due to the instability of two wheels vehicle, making it impossible to simulate open loop manoeuvres.

This paper introduces a model designed for simulating the vertical dynamic behaviour of electric kick scooters. The model takes into consideration the mechanical impedance of the driver, allowing for an estimation of the overall driver's comfort and road holding capabilities. The simulation model consists from three main part: main vehicle model, the tire and its interaction with road and human body modelling. In vehicle dynamic simulation, the tire model is the first and most crucial aspect to consider. This is because the tire is the only component that comes into contact with the road pavement and is responsible for providing a force required for movement (Karpenko *et al.*, 2023). In current simulation for driver a simple multibody models reproduce by the biomechanics in dynamic simulations is used.

The obtained results present a planar model that enables simulation of the driving electrical kick scooter in vertical dynamics. This model takes into account the mechanical impedance of driver, which significantly impacts the dynamics of the entire system. To adapt the approach to this new context, simplifications were made while utilizing conventional methods used for modelling the mechanical impedance of the human body for structure excitation. Furthermore, the paper shows simulation result envelope curves for lumped different obstacles by driving the electrical kick scooter for established drive safety and risk factors of use electrical kick scooter in urban area. The obtained results allow to define the critical risk of driving electrical kick scooter in urban area through different type of obstacles.

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GRAPH-BASED APPROACH FOR PERSONALISED TRAVEL RECOMMENDATIONS

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Keywords: personalisation, MaaS, route recommendation, human mobility data, trajectory modeling

Nowadays, mobility is one of the fundamental human rights. As part of *United Nations Sustainable Development Goals* (Assembly, 2015), people should have access to safe, affordable, accessible and sustainable transport systems with special attention to the needs of individuals in vulnerable situations, women, persons with disabilities and an aging population.

Route recommendation based on user-centric approach, is a relatively new field of study that aims to enhance user experiences, by customizing travel routes to meet their particular needs. This approach is based on the idea that people have distinctive mobility patterns that can be used to create personalised recommendations, making it simpler for them to navigate unfamiliar environments and safely benefit from their travel experiences.

Advancements in machine learning techniques and the abundance of large-scale user data have facilitated the classification of this research into three distinct categories: Point of Interest (POI) recommendation, trip planning, and trajectory modeling. POI recommendation techniques such as *collaborative filtering* (CF) and *matrix factorization* (MF) make use of a variety of variables, including user preferences, social influence, and geographic proximity, to recommend pertinent points of interest (Li *et al.*, 2015; Cheng *et al.*, 2016; Ayala-Gomez *et al.*, 2017); on the other hand, trip planning algorithms employ *Monte Carlo based methods*, to suggest a sequence of POIs that adheres to user preferences while addressing limitations like time and distance (Chen *et al.*, 2015; Chen *et al.*, 2017; Lim *et al.*, 2018); and lastly, trajectory modeling approaches extract spatiotemporal patterns of user behavior, by using various *recurrent neural network* (RNN) models, to forecast future locations and suggest the best routes (Alahi *et al.*, 2016; Liu *et al.*, 2016; Gao *et al.*, 2017).

However, for developing more personalised algorithms there are still several challenges that need to be addressed, such as the quality of the data including incompleteness and availability; the assumption that preferences and user constraints remain static over time; additionally, the lack of assessment concerning the safety and security of the proposed routes.

The purpose of this research is twofold. In the first place, a holistic understanding of *human mobility data* (HMD) is provided, including a description of sources, attributes, types and formats. Subsequently, a new set of requirements are established in the context of Personalisation, as well as, a pipeline for data pre-processing for further modeling. To realize it, we use open data from the city of Sussex (UK) due to their completeness and richness.

Therefore, the suggested pipeline consists of the following stages:

1) real-world data retrieval – weather, traffic, pollution, road infrastructure, public transport services, freight quality, etc – based on a city of interest (Sussex);

2) preparation of the publicly available *Sussex-Huawei Locomotion Dataset* (Gjoreski *et al.*, 2018), which contains GPS data, accelerometer data, social interactions and other relevant information about human mobility patterns, collected from a single participant over a period of 7 months, that serve as a training set for the next task;

3) synthetic data generation, which explores a RNN-based technique, called *conditional generative adversarial network* (CTGAN) using the previously cited dataset, to recreate a simulated agent with similar features - this data augmentation task is fundamental for leveraging the output of route recommendation algorithms;

4) implementation of trajectory modeling algorithm and visualization of “popular” trajectories on a bidimensional map of the city, highlighting preferred transportation modes, POIs, mobility patterns and travel diary of the user.

5) evaluation of the model using popular quality metrics, such as accuracy, precision, recall, and F1-score.

To conclude, the task of travel recommendation plays a fundamental role in Mobility-as-a-Service (MaaS) as it enables the system to suggest the most efficient and reliable routes based on individual users’ preferences, real-time information, constraints and social interactions.

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OPTIMIZING RIDE-SHARING POTENTIAL IN NEW YORK CITY: A DYNAMIC ALGORITHM ANALYSIS OF PEAK AND OFF-PEAK DEMAND SCENARIOS

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Keywords: dynamic algorithm, data analysis, key performance indicators

Ride-sharing has become a popular mode of transportation. However, there are still many challenges, including optimizing the number and routes of vehicles to meet the demand of passengers. This paper aims to study ride-sharing systems through dynamic algorithms, to reduce the number of cars on the road while meeting the transportation needs of passengers.

Several studies have explored different aspects of ride-sharing services. One found that ride-sharing services are less likely to be used by individuals who also use public transit (Clewlow, 2017). Another study showed that trip length could be reduced by 40% or more (Santi *et al.*, 2014).

An investigation into taxis in Singapore resulted in ride-sharing being able to serve 20%–25% more taxi booking requests and reduce traveler waiting time during peak hours (Wang *et al.*, 2022). The environmental benefits of ride-sharing have also been studied. Using shared taxis in Beijing as a case study, researchers found that shared taxis, with a maximum of two rider groups, save 28.3 million gallons of gasoline per year (Guo and Xu, 2020).

The data of New York City (NYC) Taxi from January to June 2016 was analyzed using a step-by-step approach to identify demand patterns that differed on weekdays versus weekends and peak versus off-peak hours (Commission, 2018).

A heuristic algorithm is defined for a time-constrained version of the advance-request, multi-vehicle, many-to-many Dial-A-Ride problem with Time Windows (ADARTW). This builds up vehicle tours through the sequential insertion of customers and uses a nonlinear objective function to guide such insertions. The problem has two constraints: service quality and operative. The first constraint ensures that each customer's ride time and actual pick-up time do not exceed pre-specified maximums. The operative constraints assume finite vehicle capacity and do not allow vehicles to wait idly while carrying passengers.

Since the simulation produces a range of outcomes depending on its assumptions and errors, no-sharing scenarios are intended to act as a benchmark against which to compare the outcomes of sharing. To do sharing scenarios, at each step, a specific percentage is subtracted from the estimated number of taxis in the zero scenarios, and various key performance indicators (KPIs) are compared to determine the optimal number of taxis for the demand of NYC from the viewpoints of customers (waiting time, additional ride-time, and comfortability) and taxi companies (distance and rest time of vehicles). A Decision Factor considers each parameter's impact with appropriate weight to make an informed decision. This enables selecting the best scenario that delivers desired results for each group.

The outcome shows that the number of needed vehicles in NYC for off-peak hours can be reduced to 30% and for peak hours to 40% during weekends and 50% during weekdays in case of using share taxis.

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SMART CITY AND SMART PORT CONCEPTS: A CONCEPTUALISATION FOR DIGITAL SMALL AND MEDIUM-SIZED PORT-CITY INNOVATION ECOSYSTEMS

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Keywords: port-city ecosystems, regional development, innovation policy, sustainability transition, digital transformation

European Ports are about to take an important step towards their future economic development. Existing legislations such as the European Green Deal are changing the perspective on ports as individual logistic institutions and demand a more holistic view on ports in their characteristic as ecosystem involving several different actors in an interdisciplinary and multilevel approach.

A special role is taken by small and medium-sized ports (SMSPs) facing the same political restriction and future goals like big ports - such as reducing environmental impacts with 2030 and 2050 as targets – while suffering from low financing capacity, outdated infrastructure, low innovation measures and missing political support. In contrast, they are playing a key role in regionaleconomic development and cross-border logistics as well as facilitator for the regional hinterland. Also, in comparison to theirbig counterparts, SMSPs are often located within or close to city areas. This does not only bear more challenges especially when it comes to the environmental performance but can also enable growth potentials by putting the city as a key actor into the port ecosystem.

For city development, the Smart City concept is one of the keystrategies currently applied for digital transition, mostly persistingon demonstration level in selected cities. However, the basic idea behind is par to the Smart Port concept: integration of digital technologies, upscaling processes into digital ones, test and apply future-oriented digital concepts such as AI or Digital Twins as wellas shift to a more user-based process design. Thus, this paper is analysing potential synergetic digitalisation effects resulting fromthe application of Smart City and Smart Port concepts for SMSPs' ecosystems closely located to cities with spillovers to greening measurements and economic performances as well as strategic positioning of the ports in Smart City initiatives.



Sustainable Transportation

ON SAFETY ASPECTS OF AMMONIA AS MARINE FUEL

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Keywords: maritime safety, ammonia, alternative marine fuels, decarbonisation

Despite the fact that maritime transport represents one of the most energy-efficient transport modes shipping, global shipping sector is responsible for up to 4% of the total CO₂ emissions. Hence, International Maritime Organisation (IMO) fixed measures in a greenhouse gas (GHG) strategy to reduce the emissions of greenhouse gases from international shipping industry. The initial GHG strategy envisages the reduction of CO₂ emissions from shipping industry by at least 40% until 2030 and by at least 50% by 2050 compared to 2008.

One approach for the implementation of the IMO GHG strategy is the use of alternative marine fuels comprising biofuels, electricity as well as e-fuels. Currently, the scientific and technical discussion highlighting ammonia (NH₃) as one important alternative marine fuel. The scientific focus on ammonia as fuel is based on its carbon free composition and the efficient synthesis based on research done in the beginning of the 20th Century. Ammonia should be usable in classical combustion engines but also as a hydrogen-carrier for the further production of electricity in fuel cells. In both applications, the ammonia fuel has to be stored and further treated in the vessels which leads to a variety of open questions related to ship constructions, space requirements as well as for safe ship operations.

Literature review reveals that safety aspects together with the techno-economic assessment of ammonia propelled vessels has not been covered much in the scientific literature until now. A reason for that might be that traditional ship engine producers just started to develop ammonia driven engines together with their technical handling systems so that techno-economic estimations for ship constructions, ship operations and safety compliance requirements can be only gained by results from pilot studies, the analysis of safety regulations or by reasoning by analogy. The shipbuilding industry as well as operators are at the very beginning of implementing ammonia as fuel, since there are right now zero orders for ammonia fuelled vessels. Nevertheless, a lot of experience for ammonia as cargo is available and there is a market for ammonia tankers to be retrofitted with ammonia as fuel.

The current study investigates the research question how to assess the techno-economic requirements for using ammonia as marine fuel on ships together with the related safety aspects. The research is based on secondary data research, preliminary-safety guidelines, case studies and expert interviews. The authors participated in several national and international projects about the use and the techno-economic assessment of marine fuels for shipping industry whereas the empiric data collection took place between 2020 and 2023.

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ASSESSMENT OF THE STRATEGIES OF MARITIME TRANSPORT SECTOR ORGANIZATIONS TO REDUCE THE NEGATIVE IMPACT ON THE ENVIRONMENT

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Keywords: maritime sector, transport organizations, environmental strategies, pollution, greenhouse gas

Greenhouse gas (GHG) emissions in all energy end-use sectors have been increasing since the 1970s. This increase was very sharp in the transport sector, more than doubling. The environmental pollution and negative impact on human health caused by the transport sector is one of the most widely discussed topics (Gilbert *et al.*, 2018). It is important to study the causes of negative environmental impacts and find possible solutions to reduce these impacts on a global scale by establishing guidelines to achieve this (Johnson *et al.*, 2020).

In 2015, the parties to the United Nations Framework Convention on Climate Change (UNFCCC) reached an agreement on climate change known as the Paris Agreement. Although international shipping is not included in the Paris Agreement, the International Maritime Organization has committed itself to also contribute to the solution of climate change issues and accordingly purposefully change its strategic plan according to the guidelines of the Paris Agreement (EMSA, 2022). The increase in the global commercial fleet leads to a greater negative impact on the environment and public health. Although international agreements aim to reduce the negative impact of the commercial fleet on the environment, this is becoming increasingly difficult to achieve as cargo flows increase. Projections of future emissions show that, if no measures are taken, CO₂ emissions from ships by 2050 will be twice as large as the current one. According to the IMO report, in 1996-2007 CO₂ emissions from ships, which make up total anthropogenic (related to human activity) CO₂ emissions, increased from 1.8 to 2.8% (Winnes *et al.*, 2015; UNCTAD, 2021).

For this reason, the IMO has approved additional measures to reduce CO₂ emissions over the past decade. However, installing or upgrading innovative and greener systems on ships is not cheap, and this creates additional costs for shipowners and affects ship freight rates, which also affect the cost of cargo transportation (IMO, 2022). For this reason, strategies aimed at reducing the negative impact of maritime transport on the environment become even more relevant and require special attention (Abosedo *et al.*, 2016; Amrollahi and Rowlands, 2017). So, the question is, are the strategies that are currently applied and adopted effective and successful? The purpose of this article is to provide a summary assessment of the environmental pollution reduction strategies applied by selected organizations in the maritime transport sector and to provide recommendations on how to increase the viability and effectiveness of their applied strategies.

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MODELLING OF HYDRODYNAMICS PROCESSES IN LIQUEFIED NATURAL GAS TRANSPORTATION SYSTEMS

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Keywords: liquefied natural gas, maritime infrastructure, liquefied natural gas transportation system

Global natural gas resources are increasing in availability and diversity across the world. One of the most commonly used types of vessels in the global shipping fleet is the Floating Storage and Regasification Unit (FSRU), which allows for the storage, reloading, and regasification of natural gas for injection into the gas grid. Reliable technological processes are essential for effective system operation, such as controlling tank hydrostatic pressure, vapor pressure, LNG density, LNG temperature, and phase changes between liquid and gas states. Pressure monitoring is also critical during transit in port and bunkering to prevent the pressure in the tanks from exceeding their design pressure.

This research study developed a comprehensive hydrodynamic model for an LNG storage tank in a real-life regasification terminal, specifically the Floating Storage and Regasification Unit located in the LNG Terminal of Klaipeda City, Lithuania. The model investigates LNG as a compressible liquid and evaluates the speed of sound in LNG. Using a complex mathematical model, the study analyzes high-speed hydrodynamic and dynamic processes at cryogenic temperatures (110 K), evaluating geometric parameters such as tank geometry, electric motors and pumps, pipe geometric parameters, and roughness of internal surfaces, as well as the characteristics of pumps and electric motors. The mathematical model determined key parameters, such as pressure, velocity, liquid level of LNG in the tanks, electric motor angular velocity, torques, hydraulic energy losses, etc. during the system's start-up mode (up to 5 seconds).

The study found that hydraulic energy losses in all pipes contain only 1.7% of the entire system's power (the total power of the electric motors is 3132 kW). In the event of increasing energy costs, this model could be utilized to control energy losses during the operation of the FSRU in various technological modes.

CORPORATE TRANSITION TO SUSTAINABLE LOW-CARBON DEVELOPMENT AS A FACTOR OF MARKET BENCHMARKS’ DYNAMICS

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Keywords: sustainable development, low-carbon development, carbon market, market benchmarks

The corporations’ transition to sustainable low-carbon development under the auspices of the UN global initiatives has an increasingly significant impact on all areas of modern society, including financial markets. The dynamics of market indicators begins to be influenced by new determinants, which defined the research purpose – to assess the impact of factors reflecting the corporate transition to sustainable low-carbon development on market benchmarks. Therefore, the following tasks were set and solved:

- to systematize the research on the impact of the corporate transition to sustainable low-carbon development on their investment characteristics;
- to formulate hypotheses about the factors’ impact on the corporate transition to sustainable low-carbon development on market benchmarks;
- to test these hypotheses;
- to propose recommendations for the development of methodological approaches to investment analysis and regulation of financial markets.

Having systematized the research on the impact of the corporate transition to sustainable low-carbon development on their investment characteristics, the authors concluded that the problem of the impact of new factors on the performance of financial markets is considered in the scientific literature from different points of view. A significant number of studies confirm the influence of environmental, social and governance factors (ESG factors) on market capitalization, risks, and financial profile of a business.

The revealed connection of market indicators of individual companies with the results of the introduction of new cost and investment management practices should mean that market benchmarks begin to depend on new factors. Verification of this assumption deserves independent attention but is accepted by default in existing studies. Given this gap, we formulated and tested the main hypotheses which can be formulated as follows:

H0: factors associated with the corporate transition to sustainable low-carbon development have a significant influence on a market benchmark;

H1: these factors do not have a significant influence on a market benchmark.

The main hypotheses were decomposed into four pairs of sub-hypotheses: a) the indices of the largest emerging market in Eastern Europe (Moscow Exchange IMOEX and RTSI) were alternately used as market benchmarks; b) corresponding hypotheses were tested in two stages: before the adoption of the UN sustainable development goals and the Paris climate agreement (from 2012 to 2015) and after the introduction of these global initiatives (from 2016 to 2021).

The predictors were divided into three groups: sustainable, high carbon and risk factors. The group of sustainable factors included the Russian Indices of Responsibility and Openness (MRRT) and Sustainable Development Vector (MRSV), the global ESG index FTSE4Good GB and the similar European index FTSE4Good EB as well as futures contracts for EU carbon units and natural gas. The second group of factors was formed by futures indices for oil, coal, and aluminum. The rate of return on ten-year federal loan bonds was used as a risk factor.

To test the hypotheses, methods of correlation and regression analysis were used, which made it possible to develop four multi-factor models of market benchmarks (for IMOEX and RTSI for two analyzed periods), confirming the hypotheses put forward. Several factors associated with the transition to a sustainable low-carbon development (MRRT, FTSE4Good EB, EU ETS and natural gas futures contracts) were found to have a significant impact on market benchmarks. At the same time, in the period after 2015, the relative importance of these factors increases.

The research contributes to a methodology for assessing the impact of a corporate transition to sustainable low-carbon development of financial markets. It also confirms the independent significance of testing market benchmarks depending on the relevant factors, the choice of which has confirmed its relevance for the Russian market and can be tested in other conditions. The study results have the practical importance for investment analysis and can also be used to regulate financial markets.

Acknowledgements

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SOME CAUSES AND EFFECTS OF PRESSURE PULSATION IN A HYDRAULIC SYSTEM INCLUDING THE IMPACT ON THE ENVIRONMENT

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Keywords: pressure pulsation, pump capacity pulsation, vibrations, damping, hydraulic resonance

Positive displacement pumps are components in the hydraulic systems of many machines used in transportation systems. Hydraulic systems are commonly found in mobile machinery, military vehicles, aircraft and marine vessels. They perform the most responsible functions there, and the demands placed on them are constantly increasing. The paper points out that the positive displacement pump is an important source of pressure pulsation in the hydraulic system (Wengang *et al.*, 2023). A theoretical analysis of displacement pump capacity pulsation was carried out. In a hydraulic system, capacity pulsation contributes to pressure pulsation. The spectrum of pressure pulsations also includes components at lower frequencies. In some cases, these components are the result of mechanical vibrations acting on hydraulic valves (Stosiak *et al.*, 2023). It has been noted that hydraulic resonance phenomena can occur in a hydraulic line in certain situations. A complex univariate was used to determine the frequency characteristics of the system with a hydraulic long line by subsequently determining the transmittance of the system. Analysis of the change in the transmittance value of the system as a function of the length of the hydraulic line at a fixed pressure pulsation frequency makes it possible to determine the lengths of the hydraulic line at which amplification of the pressure pulsation amplitudes occurs. This can then form the basis for the design of the hydraulic system by selecting such pipe lengths and arrangement of system components to avoid hydraulic resonance. It has been pointed out that increased pressure pulsation affects the surroundings, including human beings, causing an increase in the noise generated into the surroundings and increasing vibration levels. The effect of vibrations on humans is unfavourable and particularly dangerous when the frequency of the vibrations acting on humans is close to the resonance of the human internal organs. At the same time, usually the smaller the human body organ, the higher its natural frequency. In order to minimise pressure pulsations in the higher frequency range, passive pressure pulsation dampers have been proposed. An active pressure pulsation damper was proposed to reduce pressure pulsations in the low frequency range (<100 Hz).

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Artificial Intelligent Applications

A CASE STUDY ON RETROREFLECTIVE MARKER USAGE IN INDUSTRIAL 3D LIDAR APPLICATIONS

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Keywords: LiDAR, retroreflective, industrial application, localization, object detection, SLAM

The use of LiDAR technologies in various application areas such as topography, geoscience, atmospheric and robotics emerged early on, but the applications were rather specific and not yet widespread. Due to the demands of autonomous driving, there has been a massive growth in the market since the early 2000s, with a multitude of companies competing with different technological approaches that are constantly improving the sensors, becoming more powerful, compact and affordable (Roriz *et al.*, 2022). Due to these developments, industrial application areas are also driven forward. Like autonomous driving, the perception and localisation of use case specific objects is a key focus of the research. But upstream processes such as calibration and SLAM (Simultaneous Localization and Mapping) are assigned high importance too. Under certain conditions, solutions often cannot meet the accuracy and precision requirements of the use case.

This paper addresses this subject in the context of industrial applications and illustrates possible solutions to meet challenging requirements. Therefore, different areas of application are analysed outlining possible solutions by reviewing existing scientific work. The study focuses on the use of visual markers in 3D LiDAR data, especially retroreflective markers, their possible applications as well as their pros and cons. Subsequently, three use cases are depicted along with potential solution approaches. All the use cases originate from highly different industries and involve entirely different challenges.

First, an assistance system for crane operators and foundries is being considered, which can also provide the basis for later automation. This system targets the problem that the crane operator of portal cranes is not able to see both crane hooks simultaneously. As a result, the operator alone cannot ensure that the crane hooks are properly in contact with the casting pan pins, creating potential safety issues. Earlier work (Sopauschke *et al.*, 2023) introduced a solution based on LiDAR and registration algorithms. We present a method that builds on the state of development and increases reliability and accuracy using retroreflective markers.

Secondly, a use case from automation in production and logistics is considered. Explicitly, it is about the development of a LiDAR-based safety application for the reliable detection of objects, explicitly people for the surveillance of fenceless robot cells in which humans, robots, goods and autonomous vehicles interact and co-exist (Groneberg *et al.*, 2023). The aim is to show how retroreflective markers can be used to improve the reliability of Deep Neural Networks and/or to validate their predictions.

Furthermore, potential applications of retroreflective markers in underground mining are discussed. Surveying in mining is an important task for which the accuracy of localisation and SLAM methods is substantial. Since this is a GPS-denied environment, we will explore possibilities to make GPS information accessible in underground mining. Use cases will be outlined in which retroreflective markers can be used for drift correction, localisation and guidance (autonomous driving). The relevance and actuality of this topic have already been demonstrated by (Kumar *et al.*, 2023) and (Kurz *et al.*, 2022).

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ANOMALY DETECTION FOR INTRUSION DETECTION/PREVENTION SYSTEMS USING MACHINE AND DEEP LEARNING: EXPERIMENTAL STUDY AND FEATURE REDUCTION APPROACH

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Keywords: network traffic anomalies, intrusion detection, detection accuracy, optimal features sets dimension

The introduction of artificial intelligence (AI) methods for effective intrusion detection or prevention systems (IDS/IPS) is a promising task. This study focuses on the possibilities of anomaly detection using machine and deep learning (ML/DL) methods, particularly in the context of network traffic analysis. Two main groups of methods for intrusion detection, namely signature analysis and anomaly analysis, are examined. While signature analysis requires precise knowledge of network exchange protocols, anomaly analysis leverages artificial intelligence techniques when accurate protocol knowledge is unavailable.

The study utilizes publicly available datasets, NSL-KDD and UNSW-NB15, containing information about various types of anomalies, to evaluate the effectiveness of detecting anomalies occurring at different frequencies. Additionally, the study discusses the possibility of reducing the dimensions of datasets and the impact of such reduction on accuracy.

The authors build upon a previous study (Grakovski *et al.*, 2022) that demonstrated satisfactory accuracy in detecting anomalies similar to DoS attacks using standard ML/DL methods. However, improving methods for feature reduction while maintaining high accuracy remains relevant.

Based on numerical experiments, the study formulates a hypothesis suggesting that the main set of features identified using an AHP-like method forms ensembles with different weight coefficients. The results confirm the hypothesis, indicating that this approach can be applied to all types of anomaly detection and ML/DL methods.

Furthermore, the modified method proposed in the article establishes that there is a minimum dimension of feature sets for each network configuration, allowing the recognition of anomalies with maximum possible accuracy, albeit limited.

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REVIEW OF AI-BASED VISION DETECTION ALGORITHMS FOR AUTONOMOUS MOBILE ROBOTS

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Keywords: review, vision, detection, algorithm, AI, autonomous, mobile robot, algorithmic

This study presents a comprehensive review of AI-based vision detection algorithms for autonomous mobile robots. Over the years, research on autonomous mobile robotics, artificial intelligence (AI) and vision detection algorithms has significantly advanced. Furthermore, an in-depth analysis of some AI-based image detection algorithm for autonomous mobile robots is presented, demonstrating the complicated web of factors that go into creating an algorithm, including the algorithmic approach, methodology, data training, performance standards, real-time implications, and potential for improvement. This study acts as a roadmap for the development of improved AI-driven robotic vision systems as the algorithm's capabilities continue to change the field of artificial intelligence.

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DEVELOPMENT OF A CONCEPTUAL NETWORK FOR AI-BASED MANAGEMENT AND LEADERSHIP APPLYING GRAPH THEORY

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Keywords: graph theory, AI-based decision making, management and leadership, network optimization, decision-making network

This paper aspires to create a conceptual framework using graph theory to articulate management and leadership decisions, thereby encouraging AI-based solutions. Initially, we delve into the complexities of graph theory (Diestel, 2005), a mathematical field examining structures connecting pairs of objects. This understanding is then employed to map out the broad range of decisions that leaders must navigate, arranging these decisions from the least to the most critical within organizational operations.

Relying on established literature on management and leadership (Northouse, 2018), we formulate a hierarchy of decisions and leadership tasks. These tasks form the backbone of any organization and are utilized to develop a simplified yet comprehensive conceptual graph network. This network encapsulates the interdependencies and complexities inherent in these decisions, thereby effectively mirroring the decision-making framework in management.

Subsequently, we incorporate groundbreaking insights from AI-based decision-making (Russell and Norvig, 2016) to propose algorithmic solutions that traverse this network. The aim here is to automate specific tasks, thereby enhancing efficiency and allowing leaders to focus their energies on strategic, non-automatable decisions.

Lastly, we apply mathematical methodologies and graph network strategies (Barabási, 2016) to decipher and optimize this decision-making network. In effect, this paper conceptualizes a novel blend of graph theory, AI, and leadership, which holds the potential to revolutionize how we perceive and manage managerial decisions.

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FORECASTING IT PROJECT COMPLETION TIME: ARTIFICIAL NEURAL NETWORKS APPROACH

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Keywords: IT projects, pricing methodology, artificial neural network, developed learning models

This paper presents a methodology for predicting the required time for software development in IT projects and the necessary labor costs, based on trained artificial neural networks. The study aims to develop forecasting models to predict the execution time of IT projects, with the goal of improving project planning, control, and pricing methodologies in IT companies (Jorgensen, 2007), (Menzies *et al.*, 2017). The study develops four models for predicting execution time for specific types of IT projects, including simple and complicated learning models based on artificial neural networks (Arbain, 2019), (Brar, 2022). To validate the accuracy of the developed methodology, the study utilizes expert assessment of the technical management of the project. The results of the study demonstrate the effectiveness of the developed forecasting models, which have been successfully applied to plan and control projects with subsequent correction of results by retraining the developed models and the specifics of the client, country, and type of project.

The study object is IT companies, and the study subject are pricing patterns in the IT industry.

The study recommends that IT companies adopt the developed methodology, what include quantitative and qualitative research methods: monographic method, content analysis, forecasting methods, statistic methods, to improve project planning, control, and pricing (Santos *et al.*, 2023). Further research could focus on the development of additional models for predicting execution time for different types of IT projects or exploring the use of other machine learning techniques in project forecasting (Veido *et al.*, 2019). Additional research could also explore the impact of external factors, such as market trends, economic conditions, and regulatory changes, on the execution time and costs of IT projects.

The expected results of this study include improved accuracy in predicting the execution time and costs of IT projects, leading to better project planning, control, and pricing. The developed methodology can help IT companies increase their competitiveness by offering more accurate project estimations, leading to better customer satisfaction and improved profitability.

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THE USE OF ARTIFICIAL INTELLIGENCE TO CONVERT SOCIAL MEDIA DATA INTO ACTIONABLE INSIGHTS

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Keywords: Artificial intelligence, social data, digital marketing, transformation, marketing analytics

The massive volume of social data generated by the extensive adaptation of social media platforms proposes exceptional opportunities to understand opinion trends, customer behavior, and public sentiment. Nonetheless, extracting actionable insights from these complex datasets poses a massive challenge. Hence, this research article explores various AI methods, such as natural language processing (NLP), machine learning, and network analysis, to crack the power of social media data. Each AI method has benefits that impact businesses and enable them to make strategic decisions based on social media data. In time, evidence-based, data-driven information enables us to understand better sentiments, opinions, topics, and trends in digital media culture. Additionally, using AI to transform social media data into actionable insights has significant consequences across diverse industries such as marketing, education, healthcare, etc. Besides, it must be noted that while AI in transforming social data offers enormous opportunities, it also raises ethical considerations such as biases in data collection, privacy concerns, transparency, and so on. Therefore, the author used a three-step process in this research article: First, existing literature materials were explored using exclusion and inclusion criteria. Second, a survey study was conducted with 200 respondents. Third, multiple regression analyses were conducted to predict the importance of natural language processing (NLP), machine learning, and network analysis for transforming social data. Moreover, a focus group experiment was conducted with a marketing analytics class with 27 students. Results of the analysis revealed that the combination of independent variables significantly predicted the use of artificial intelligence for converting social media data into actionable insights, $F(3, 196) = 67.143, p < .001$, accounting for 51% ($R^2 = .507$) of the variance in the use of AI. The variables of NLP ($\beta = -.285, p < .001$), machine learning ($\beta = .407, p < .001$) and network analysis ($\beta = .275, p < .001$) were statistically significant predictors. Further, findings indicated that using AI to transform social media data into actionable insights carries significant value for businesses, marketing practitioners, and decision-makers. NLP, machine learning, and networking analysis techniques are statistically significant in extracting valuable information from complex datasets, besides allowing us to identify critical trends and gain deep insights from across the globe.

COMPARISON OF CLASSICAL DECISION-MAKING METHODOLOGIES WITH AI-BASED DECISION-MAKING METHODOLOGIES APPLIED ON MANAGEMENT DECISIONS

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Keywords: decision-making in management, cost-benefit analysis, random forest algorithm, artificial intelligence methodologies, hybrid decision-making models

The significance of effective decision-making in management is undeniable, impacting all facets of operations and influencing organizational success. This paper delves into the contrast between traditional and artificial intelligence (AI)-based decision-making methodologies, elucidating their distinctive features in management decisions.

Classical decision-making methodologies, such as Cost-Benefit Analysis (CBA), have long served as vital tools in management decisions (Parker and Rogers, 2006). The CBA provides a systematic approach to determine the value efficiency of decisions, such as loan approvals.

Contrastingly, AI-based decision-making models, exemplified by the Random Forest algorithm (Breiman, 2001), introduce a novel approach in decision-making tasks. By processing vast data sets, these AI models offer predictive power and accuracy, especially in complex decisions like loan approvals (Zhang *et al.*, 2011).

The methodologies of the applied research are secondary data analysis with a classical decision-making method as well as secondary data analysis with an AI algorithm. The data the study is considering are open accessible loan decisions of an anonymous financial organization.

By applying both the CBA and Random Forest algorithm to loan approval, the paper reveals notable differences. While CBA depends on human interpretation, the Random Forest algorithm harnesses data-driven insights, offering potential improvements in decision-making accuracy and efficiency. Based on this application, the paper discusses both approaches in a detailed SWOT analysis which summarizes the strengths and weaknesses of the two variants. This analysis is combining qualitative aspects of the methodologies as well as quantitative aspects.

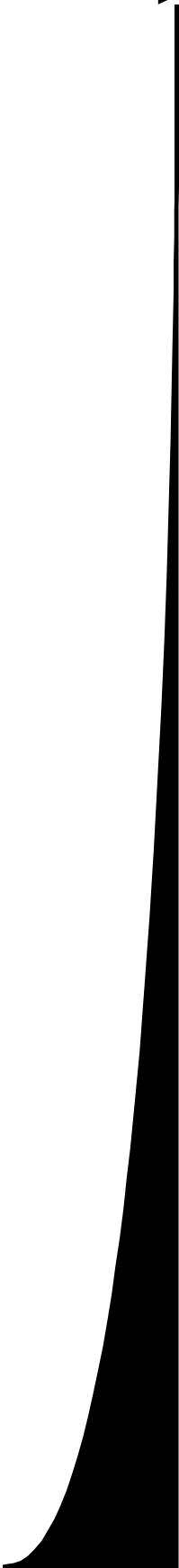
Understanding both classical and AI-based methodologies is crucial for managers in today's data-rich business environment. The paper emphasizes that AI methodologies should be viewed as enhancements, not replacements, of traditional methods. It advocates for further research into hybrid models that integrate traditional methodologies with AI, potentially boosting the effectiveness and accuracy of managerial decision making. A comprehensive understanding of both approaches allows for more informed and efficient decision-making processes.

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Aviation



AVIATION TECHNICAL SUPPORT AS A SERVICE MODEL FOR AIRCRAFT OPERATION OF SMALL AIRLINES

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Keywords: aviation technical support, aviation technical support as a service, service model, small airlines, advanced technologies, maintenance optimization

The concept of Aviation Technical Support as a Service (ATSaaS) has emerged as a new and innovative approach in the aviation industry, aiming to provide comprehensive technical support services to small airlines. The paper explores the development and implementation of this model, combining state-of-the-art digitalization methods and advanced technologies to address the unique challenges faced by small airlines.

The research focuses on the customization and scalability of the service model, considering the diverse needs and requirements of small airlines in terms of aircraft maintenance and technical operations. By leveraging advanced digitalization methods, such as artificial intelligence, machine learning, and data analytics, the model aims to optimize decision-making processes, enhance operational efficiency, and improve overall safety and reliability.

The article highlights the research novelty in terms of integrating advanced digitalization methods, developing a customizable and scalable service model, and optimizing performance metrics. It explores the practical significance of the ATSaaS model by providing guidance for small airlines to access high-quality technical support services, make informed decisions, and achieve business growth and profitability.

Through a comprehensive literature review, the article examines the existing models of aviation technical support services and identifies the gaps that the ATSaaS model aims to address. The study also emphasizes the importance of collaboration between the service provider and the airline, promoting a collaborative ecosystem that fosters effective communication, information sharing, and mutual benefits.

The findings and insights presented in the article provide a foundation for future research and practical implementation of this innovative model, enabling small airlines to enhance their technical operations and achieve sustainable growth in a rapidly evolving industry.

VALUE PROPOSITION BENCHMARKING: A CASE STUDY OF MIDDLE EAST AIRLINES

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Keywords: value proposition, aviation, benchmarking

The purpose of this research paper is to explore how companies in the airline industry can measure their value proposition in comparison to their competitors. This study uses a mixed-methods approach to analyze the websites and social network profiles of top Middle East airlines taken as a case study to identify the values as part of value proposition.

The first step of the analysis involved a qualitative content analysis of the websites of the top Middle East airlines to identify the values they emphasized in their marketing messaging. These values were then categorized and compared to create a comprehensive list of Middle East airline values.

Next, a quantitative analysis was conducted to determine how the values mentioned on the top Middle East airline websites compared to the aggregated values of major airlines in the market. The study used various procedures including identifying size, geography, and market position to determine similar groups for comparison purposes when evaluating airline competitors' values.

The comparable groups' values were analyzed and compared with those of the leading airlines to identify differences and similarities. With the help of this study's insights, companies in aviation and other industries can comprehend how they position against their rivals regarding values and to define the fields where they can enhance their performance.

The comparison analysis based on cutting-edge startup values allows to incorporate novel values into the company's value proposition and thus gain an advantage in the competition.

SUITABILITY OF INVENTORY POLICIES FOR SUPPLY OF SPARE PARTS IN AVIATION INDUSTRY

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Keywords: spare parts logistics, aviation, inventory control, procurement

The issue of supplying spare parts for the aviation industry remains highly relevant. Every day, the procurement group has to decide how to deliver spare parts in the best way: for purchase, in exchange, for repair in advance. The purchase method involves the acquisition of the component's ownership. With the exchange method, a replacement component is first supplied to fix the fault, and removed defective unit is sent back to the supplier for further repair. In this case, repair costs are also charged to the buyer. In the advance repair method, the airline repairs the removed defective units in advance. This method implies the presence of replacement blocks in the warehouse.

There is a need for airlines to adopt such methods and systems, in which the problem of providing spare parts and components is considered not only from the point of view of aviation safety, but also from the point of view of economic efficiency. Such systems must explicitly consider all three factors: the high cost of maintaining aircraft, the financial losses during their downtime, and the cost of delivering spare parts. Unsatisfactory spare parts supply results in additional aircraft downtime in the hangar, which in turn reduces the productivity of the technical staff working on the aircraft. Another negative factor is the loss of customers who refuse to have their aircraft maintained at the MRO due to the lack of a pre-agreed service slot.

This study examines the 5 best known and most widely used mathematical models (methods) for inventory management in terms of managing the supply of components and spare parts for aircraft equipment. It should be kept in mind that all the studies reviewed are not comprehensive, but mainly deal with individual problems related to the feasibility of purchasing and calculating the necessary quantity of spare parts for replenishment, as well as determining the optimum time to place an order.

The aim of this paper was to determine whether traditional inventory management methods are applicable in the aviation industry and to select the most appropriate among them.

The main complexity in applying traditional methods lies in the varying needs in the supply chain of any production line and the sometimes not well predicted needs of an airline for units arising from defects. We can therefore speak of the limited application of inventory policies applied to spare parts logistics in the aviation industry.

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CHOOSING OPTIMAL MAINTENANCE SERVICE LEVEL DEPENDING ON FINANCIAL MODEL OF AIRCRAFT MAINTENANCE ORGANIZATION

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Keywords: material shortage, inventory management, excessive inventory, airline profitability, service level, MRO revenue

To be on time with aircraft maintenance is of crucial importance for aircraft maintenance organisation to ensure the revenue plan and for airline to fulfil the flight plan and have enough carriage capacity. Experience of a maintenance organization A shows that 90% of all delays that happened during base maintenance were caused by non-delivery of spare parts on time.

On one hand overstocked warehouse with spare parts could help to improve service level and reduce the quantity of delays. On another hand excessive stock leads to extra carrying, stocking and transactional costs that reduces the revenue of a maintenance company alongside with the delays caused by stock out.

Having gone through COVID-19, political instability, supply chain rupture, constant change in aircraft maintenance planning makes it more difficult to procure spare parts, have deep planning horizon and define the optimal percent of service level.

This work provides a solution on the optimal service level of expendable and consumable spare parts availability that independent private MRO could have in order to maximize profit when providing service doing heavy maintenance on aircraft type Boeing and Airbus. As well this work has figured out parameters and characteristics that have an impact on service level in order to be able to handle it.

STRATEGIES OF SUSTAINABILITY IN THE AVIATION INDUSTRY: THE SINGLE EUROPEAN SKY PROJECT

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Keywords: sustainability, aviation, single european sky, free route, atc, air traffic flow management

The aviation sector is constantly developing and changing rapidly. Over the years there have been numerous studies on the sustainability of air transport, both financial and environmental, and it has never been a crucial topic before this post Covid-19 pandemic recovery.

This document will analyze the main initiatives reported in the literature regarding sustainability and competitiveness of this industry, then relating them to the Single European Sky project, which will be studied to define new strategies to address the issue.

The aim of this paper is to highlight how airspace engineering and air traffic management (ATM) can significantly contribute to improve sustainability and environmental performance, positively impacting the economy of all the players involved as well as the struggle against pollution.

In summary, the research delves into various facets concerning sustainability and environmental performance in the European Union. It specifically aims to identify and analyze potential strategies that can be implemented to improve these aspects. Furthermore, the research investigates the positive effects of these strategies on the aviation industry. Additionally, it assesses any potential weaknesses or drawbacks associated with these strategies.

VERIFICATION OF VIBRATION DIAGNOSTIC TECHNIQUE FOR FLOW PATH OF TURBOMACHINES

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Keywords: vibration diagnostics, turbomachine, flow path, high-order vibration model

Predictive maintenance of turbomachines is a forward-looking approach aimed at reducing costs and increasing efficiency. For this purpose, the condition monitoring tools are applied, that use different non-destructive testing methods, including vibration diagnostics. Though predictive maintenance is a priority goal, actual condition monitoring units (CMU) still miss most of typical damages. Advanced CMU consider vibration diagnostics for gears and bearings however, turbomachine's flow path remains out of monitoring. For instance, damaging the blades, guide vanes or combustion chamber caused by foreign objects, erosion, etc. may be crucial for engine operation. To provide predictive maintenance the diagnostic techniques should not be limited to the detection of abnormal state of flow path unit's but should quantify the degradation level in order to ensure timely planning of maintenance and repair. In case of compressor stage, for instance, quantitative estimation of the damage means a number of damaged blades or a level of its damaging. As blade and vanes are basic elements of a flow path, the diagnostic techniques should use high-order model that relates vibration to the interacting elements of flow path. To simplify application of diagnostic techniques the flow path model should be related to housing vibration of an operating turbomachine.

The paper discusses verification of the diagnostic techniques that are based on the high-order model of aerodynamic vibration. This model relates housing vibrations with aerodynamic blade- vanes interactions in a compressor or turbine stage of operating turbomachine. The model considers three basic aspects of housing vibrations: turbulent blade wakes, spatial pulse wake-vane interactions and housing response to spatial pulse excitation. The paper considers spatial pulse vibration model using ultra-wide frequency band of interactions that provides high diagnostic resolution. The techniques are presented that apply the spatial pulse model in wide-frequency band of vibrations measured on a housing of an operating turbomachine.

The test rigs and the procedures applied for the model validation and experimental verification of the diagnostic techniques are presented in the paper. To demonstrate the capabilities of diagnostic techniques based on high-order vibration model, authors illustrate examples of successful identification of compressor damages using wide-frequency vibration band. For instance, in the rotor and the stator of jet engine compressor the test faults have been seeded, like damages of blades and vanes. Vibration diagnostic parameters based on spatial pulse model provided quantitative estimation of seeded faults.

There are conclusions about spatial pulse model benefits and about capabilities of advanced diagnostic techniques using this model. The goals of further works are indicated, including development of the software providing condition monitoring and diagnostics of flow path units of an operating turbomachine.



Supply Chain Management

THE READINESS OF PORT LOGISTICS SERVICES IN THE CASPIAN SEA WITHIN THE EURASIAN TRANSPORT CORRIDOR – CASE STUDY OF THE PORT OF AKTAU

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Keywords: Eurasian transport corridor, Caspian Sea, seaport logistics services

Due to recent geo-political developments, the importance of the trans-Eurasian transport corridor, especially through the Caspian Sea has increased considerably. The Caspian Sea is strategically located at the crossroads of Europe and Asia, thus making its seaports essential for the sustainable operation of the Eurasian transport corridor. The Caspian Sea ports along with forming important transport nodes and acting as gateways to landlocked countries in Central Asia and the Caucasus, play also a vital role in the global supply chain providing the necessary infrastructure, logistics services, and connectivity to ensure the smooth transfer of goods from sea transport to land-based transportation modes, thus enabling efficient trade flows along the Eurasian transport corridor. Although the Caspian seaports provide comprehensive logistics services, including cargo handling, storage, customs clearance, and documentation; the demand for more efficient and sustainable logistics operations has grown considerably during the last year at the given ports. In the framework of quality assessment, the paper investigates the general readiness of logistics services in the ports of the Caspian Sea based on the statistical and empirical data within the case study from the Port of Aktau. Special attention within this work will be paid to the evaluation of preliminarily identified challenges such as inadequate hard infrastructure, e.g. adequate berths, insufficiency of the vessel/cargo ships, handling equipment, storage facilities and terminal container construction to accommodate growing trade volumes; limited connectivity and inter- modality, insufficient regulatory and customs procedures, e.g. cargo declaration and inspection; digitalisation of port processes and operations, availability of value-added services, customer service satisfaction, security and safety issues as well as environmental concerns.

DEVELOPMENT AND PRACTICAL APPLICATION OF HYBRID DECISION-MAKING MODEL FOR SELECTION OF THIRD- PARTY LOGISTICS SERVICE PROVIDERS

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Keywords: logistics service providers, 3PL, multi-attribute decision-making, decision-making model

Nowadays approach of outsourcing logistics operations to third parties is becoming widely used because businesses find it more efficient to concentrate on and allocate own resources, including personnel, equipment, and finances, to core business activities, should it be production, sales and marketing, or value creation. At the same time, companies nowadays compete not only by their products, but also by their supply chains. That is why, effective governor, such as third-party logistics service provider, is needed for business to build and sustain competitiveness. Taking this into consideration, need for effective collaboration and partnership strategy is becoming vital for many businesses and third-party logistics service providers. By looking at contemporary supply chain management from different angle, it is being observed, that trend of integration of information and communication technologies has been constantly increasing, and importance of proper data management and analysis for building sustainable supply chain solutions is undisputable. That is why, there is a certain need to implement modern decision-making techniques and models also for building partnership between customers and logistics service providers. These techniques must be based on data management and should substitute several traditional decision-making methods.

The problematic discussed in this study is following. Traditional decision-making techniques, that are generally widely discussed in professional and academic environments, are functionally limited and must be adjusted to solving specific task – selection and evaluation of logistics service providers. These techniques must be based on contemporary tools and information. Also, there is a need for wider methodology of building partnership with logistics service provider, that is not only limited by selection process, but also must contain a framework for decision-making.

The aim of this study is to develop a modern, industry-oriented decision-making model for selection of strategic logistics service providers.

Main tasks of this study include: to perform critical analysis and comparison of multiple-criteria decision-making methods; to adapt decision-making framework for specific needs of selection of third-party logistics service providers; to collect and analyse industry data related to procurement projects; to develop modern decision-making model for selection of logistics service providers; to perform practical application of developed decision-making model based on collected industry data.

The key novelties of this study are developed methodology for collection of industry data for decision-making process; developed hybrid decision-making model for selection of third-party logistics service provider, as well as application of the model.

As the result, developed decision-making model for selection of 3PL service providers includes 6 main steps, which are: collection of data from statistical reports of key performance indicators; establishing linkage between decision-making elements; estimating weights (importance) of evaluation criteria; benchmarking of logistics service providers; definition of ideal solution; prioritization of logistics service providers. Practical application of decision-making model proved to be reliable, based on scenario of European fourth-party logistics procurement project.

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FASHION SUPPLY CHAIN MODELING AS MAJOR AREA OF MANAGEMENT SCIENCE AND ITS DISCONNECT WITH PRACTICE

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Keywords: fashion supply chain, management science, inventory management, retail

This study aims at discovering opportunities to consider the breach between research and real business in the fashion industry. It is based on a limited review of selected representative papers available in the literature on fashion supply chains. There is a disconnect between research tools and the managerial needs. The divide often stems from lack of empirical data feeding the models of supply chain. More practical publications seem to have less research impact, which could discourage the closer link of theory to practice. Such issues are not specific to the topic of fashion supply chain but characteristic for the entire field of research in operations research and management science. The contribution of this study is in exploring the disconnect from the perspective of the peculiarities of the fashion industry where supply chain gained enormous global significance in terms of sustainability. Greater collaboration is essential between practitioners and academicians to address the urgent issues in the global fashion supply chains.

TRANSFORMATION OF SUPPLY CHAINS IN THE CONTEXT OF 'INDUSTRY 4.0'

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Keywords: supply chain, transformation, Industry 4.0

Globalization processes and scientific and technological progress lead to changes in business development. This requires restructuring supply chains. These changes are driven by rapidly changing consumer expectations and growing competition in the market. Therefore, to maintain the ability to compete in national and global markets and to deliver innovative, customer-centric products, companies must undergo digital transformations that improve productivity. All the more so that, according to Stearns (2020), the importance of industrial revolution is not only a historical event that is the most important in human history but also a constantly shaping factor of the modern world. This statement is supported by Rüßmann *et al.* (2015) and, Kalsoom *et al.* (2020), Rymarczyk (2020), who identify Industry 4.0 as a revolution defined as a new level of organization and value chain of the entire product life cycle focused on increasingly individualized customer needs. Considering this, it is necessary to adjust the specifics of modern supply chains in the context of 'Industry 4.0', which would create conditions for applying sufficiently innovative and highly efficient mechanisms for each entity. It should be assumed that only practical identification and appropriate measures can ensure a specific economic entity's successful and sustainable functioning.

This study aims to evaluate the impact of 'Industry 4.0' on the speed of transformation of supply chains. Scientific-theoretical evidence of the phenomenon, the assessment of trends and regularities, and the evaluation of factors and measures that determine the efficiency of the supply chain are necessary to achieve the goal.

The results showed that the implementation of innovations has the most significant influence on the improvement of supply chains and helps maintain the operation of an efficient production supply chain. The innovations implemented provide an opportunity to increase production capacity, improve production planning management, and improve communication throughout the supply chain.

Applicable research methods: a systematic literature analysis.

APPLICATION OF NEW TECHNOLOGIES IN THE SUPPLY CHAINS OF THE LITHUANIAN INDUSTRIAL SECTOR

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Keywords: supply chain, digitization

The world is becoming increasingly virtual, created for our convenience. The new industrial revolution 'Industry 4.0' which is focused on the automation, digitisation, and data exchange of systems and processes in various industries (Abdirad and Krishnan, 2020), (Luthra and Mangla, 2018), enables more efficient management of the supply chain to gain a competitive advantage and avoid mistakes. Technologies like Blockchain, IoT, Machine Learning, etc. increases and improves opportunities to optimise planning, supply, and purchasing strategies. According to survey data from the US research company KRC Research, 80% of company managers believe that automation saves an average of 360 working hours per year. A few examples could be: the digital platform "Cargo stream" created by Lithuanians - an advanced automated logistics management platform for maritime lines already serves the leading global maritime lines in Poland and the Baltic States; the GMC warehouse management solution is effectively applied in manufacturing companies that need to optimise warehouse processes. Digitisation in supply chain management provides an opportunity to track material flows, obtain the necessary information in real time, and make accurate and timely decisions about possible changes, enabling faster communication and better and more reliable coordination of activities. However, with the abundance of digital technologies, the problem arises: Which ones to choose not only for individual stages of the supply chain responsible for individual processes but also for interoperable digital solutions that determine the efficiency and effectiveness of the entire supply chain? The purpose of the study is to form a rationale for the digitisation of the supply chain by evaluating the main threats throughout the supply chain after analysing the scientific literature.

Applied research methods: a systematic literature analysis.

The results showed that technologies such as Big Data analytics, machine learning, artificial intelligence, and the new generation of robots are used to digitalize the supply chain. The main challenge is the compatibility of different systems and time, which is very important in today's business.

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THE ISSUES ON DIGITAL MATURITY OF WOOD-BASED SUPPLY CHAIN – CASE STUDY

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Keywords: wood-based supply chain, digital maturity, assessment method

One of the fundamental challenges of today's supply chains is to adapt to the new demands posed by the development of information and IT technologies. In this context, digital transformation is perceived as changes in the system that results in implementing technological improvements in order to increase supply chain efficiency (Buntak *et al.*, 2021). 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 is especially visible in wood-based supply chain operations (Hellweg *et al.*, 2021). Wood-based materials are products for which so-called waste wood is used, i.e. waste material generated during sawmilling and production (e.g. shavings, sawdust, chips), as well as round wood, which is processed. The proper management of physical material flows in such supply chains involves dealing with a number of problems related, on the one hand, to the product itself (e.g. weight of wood, size of material) and, on the other, to a number of challenges related to the digitalization of operational processes. As a result, this paper outlines the main problems faced by the supply chain in the wood-based materials sector in the context of building digital maturity.

As a result, the article 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 diagnosis for the case company is investigated. The article ends with a summary and directions for further research.

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INVENTORY MANAGEMENT UNDER DEPENDENT DEMAND IN THE CONDITIONS OF RISK

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Keywords: inventory management, dependent demand, supply chain, reliability

Inventory management in supply chains under independent demand has received considerable attention in recent decades (among many others, Jackson *et al.*, 2020; Prause and Prause, 2021). Significant advances have also been made in the development of algorithms for inventory management under dependent demand. On the other hand, a number of issues require further research. For example, there are virtually no approaches to the definition of safety stocks under dependent demand or the recommendations are qualitative in nature. According to Axsäter (2015), the safety stock is also a planning parameter that can be chosen arbitrarily. Ballou (1999) notes that a fixed on hand-inventory level can be maintained that is determined by practical experience or some other means. Although this method is approximate, it is probably the best that can be done.

Inventory management strategies under dependent demand assume that the probability of no-failure is represented as a constant value. The model we developed takes into account the safety stocks needed due to component defects and assumes that the probability of no-failure is a variable that obeys one of the discrete or continuous distribution laws. To the best of our knowledge, this approach has been proposed for the first time and can be used in practice to make management decisions based on the calculation of costs and reliability of supplies under dependent demand.

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Transport Technologies

STUDY OF THE LUBRICATION PROPERTIES OF BIOFUELS AND THEIR BLENDS WITH TIRE PYROLYSIS OIL

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Keywords: tyre pyrolysis oil, lubricity, biodiesel, tire pyrolysis oil

The article presents the results of the investigation of the lubrication properties of biofuel (HVO) and their blends with tire pyrolysis oil (PA15, PA30, PA60 and PA100). Durability of the injection system largely depends on the lubricating properties of fuel. The reduced durability of the fuel injection system's components, such as fuel supply pump and injectors, sometimes can be ascribed to a lack of the lubricating quality of fuel. Considering the relatively poor lubricating properties fuel one should remember that the main moving parts of the fuel system are affected by friction while working under the most difficult conditions in the diesel engine. The HFFR high-frequency sliding motion stand was used for the tests. The test was carried out in accordance with the international standard ISO 12156. To determine the lubricating properties of the fuel, wear traces were analysed under a microscope, which are formed due to the contact between a stationary fixed plate (immersed in fuel) and a ball oscillating at a frequency of 50 Hz. Analysing the obtained results, it was observed that the smallest wear diameter of 0.218 mm was obtained using mineral diesel (DD), and the highest wear diameter of 0.343 mm was recorded using pure tire pyrolysis oil (PA100).

OVERVIEW OF FACTORS AND METHODS FOR ANALYSIS OF HYPERLOOP PROJECT

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Keywords: Hyperloop, high speed transportation, sustainable transport, fifth mode of transport, emerging technology

The paper is part of the research project conducted in the scope of PhD thesis “Assessment methodology for Hyperloop technology implementation for multimodal freight transportation” conducted by Aleksejs Vesjolijs. Hyperloop project is ultra-high speed transportation mode, that is envisioned in 2012 by Elon Musk (Tesla, 2023). Goal of the current paper was to carry out assessment analysis of factors and methods for evaluating Hyperloop project during phase of initial planning from social, technical, socio-economic and environmental perspectives. Research outcomes are presented in a form of overview. This overview could be useful as an aid to decision makers such as regional and national governments, commercial transport policymakers or investors for any Hyperloop transport projects.

Disruptive technology leads to an innovation or advancement that significantly alters or disrupts an existing market or industry by introducing a new product, service, or business model. It displaces established technologies, processes, or practices, and creates a new market or changes the dynamics of an existing market. International stakeholders tend to prioritise projects that use disruptive innovations (Herrera-Quintero, 2019). Integration of different disruptive technologies is of critical importance for building effective transportation solutions (Dong, 2021). Applying disruptive innovations contribute to transportation system safety. New building materials, structural components lead to less transportation system and/or infrastructure installation costs (Baker, 2016). Hyperloop tend to be disruptive technology, possibly changing the way people and goods are transported by making it affordable, fast, climate-neutral and accessible for all groups of the society. Multi-Criteria Analysis (MCA) of the specific Hyperloop transport project in Northern Holland was proposed by (Sane, 2020), however MCA is specific to Hyperloop project in Northern Holland, proposed method how to analyse criteria, bounded by geography – Europe. Further (Sane, 2020) research limited MCA only on social, technical, socio-economic and environmental perspectives. Thus, further research was needed to cover also technical criteria and include factors in evaluation. Highlighting problem there is research gap on which methods and factors can be used for Hyperloop project evaluation during planning phase. Current paper narrowed this gap. Research focused on factors and methods on how to evaluate Hyperloop project.

The main goal was to evaluate and compare different factors, methods and innovations that have the potential to significantly impact the hyperloop implementation. This analysis aimed to identify the most relevant factors and methods that help evaluate Hyperloop project. Hyperloop project analysis helps to understand their implications, advantages, challenges, and feasibility for hyperloop components. Main components of Hyperloop (Tesla, 2023) are defined as tube, capsule, compressor, suspension, propulsion (Dhote, 2017). Disruptive innovations relevance: Autumn 2023.

Paper analysed and compared factors affecting Hyperloop project providing comprehensive overview.

Study defined the following factors:

1. Technical Feasibility
2. Quantum factor

3. Safety
4. Regulatory Approval
5. Social Acceptance
6. Reliability
7. Scalability
8. Environmental Sustainability
9. Infrastructure Integration
10. Usability

Next, research assessed methods that can be used for Hyperloop project evaluation. Further, study covered application of disruptive technologies for Hyperloop project,

such as metaverse, digital twins, nano technology, Big Data, 3D printing, Large Language Models (LLM), Quantum Computing, etc. Then, research identified potential advancements, accessed feasibility and readiness, evaluated advantages and limitations of disruptive technologies.

The rapidly developing commercial landscape of quantum computing (MacQuarrie *et al.*, 2020) has stimulated discussions regarding its applicability in Hyperloop implementation, such as in the creation and optimization of vacuum tube materials and capsule design. Moreover, the utilization of augmented virtual reality is explored in the context of maintaining and operating Hyperloop systems. This research also delves into the burgeoning concept of the metaverse, examining its communication and marketing potentials specifically for Hyperloop, through the integration of various technologies like virtual reality and artificial intelligence (Mystakidis, 2022). Furthermore, the application of the digital twins' concept is scrutinized to enhance Hyperloop's design and operational procedures. Nano technology's applicative potential is explored, presenting avenues for performance and material enhancement in Hyperloop systems. Additionally, the integration of Big Data into Hyperloop systems is studied, offering insights from a data engineering and science perspective. The application of 3D printing is considered for prototyping and optimizing lightweight Hyperloop infrastructure, while natural language interfaces, utilizing Large Language Models (LLMs), are analyzed for customer support, training, and knowledge dissemination.

Comparative analysis matrix is designed providing systematic view of factors and methods in evaluation of Hyperloop project. Existing research narrowed gap of uncertainty during Hyperloop project planning phase, introducing overview of factors and methods that could be useful and aid decision makers. Provided methods and factors are limited by social, technical, socio-economic and environmental perspectives.

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EXPERIMENTAL MODAL ANALYSIS FOR IDENTIFICATION OF LAMINATED GLASS FIBER REINFORCED PLASTIC

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Keywords: natural frequency, identification, composite material properties

At the present time fiber reinforced polymer, a widely used in aeronautics, astronautics, automotives, and weapons industry as major component. The knowledge of elastic properties of composite material is necessary for design of composite construction and they components. In compare with isotropic materials determination of composite materials properties is much more complicated and need more time and efforts. Non-destructive methods for determination of elastic properties can be regarded as alternative of the fracture methods and allows one to decrease cost of experiments. In addition, the possibility to measure the elastic modulus of the specimens after processes acting on the material (temperature variations, aging, vapours, etc.) allows one to reduce consumption of material. Based on the vibration features of plate type structures elastic properties of composite material can be identified without fracture of composite structure. In compare with fracture method determination of composite materials properties in the presented method is rapid and inexpensive (Rikards *et al.*, 2003).

The numerical-experimental method for determining the properties of a composite material from experimental modal analysis consists of several stages. At the first stage, the frequencies and modes of natural vibrations of the composite materials are experimentally determined. At the second stage, the estimated values of the elastic constants of the composite materials are selected and an experimental plan is created. Numerical calculations of composite plate are carried out in each point of plan to determine frequencies. Collected numerical data are used to determine simple functions using a response surface method. Finally, the identification of the material properties is performed by minimising the error functional, which describes the difference between the experimental and numerical parameters of the structural responses (Barkanov *et al.*, 2007).

When solving the identification problem, it is recommended to take plate for identification procedure with certain sizes. The objective of this study is identification of glass fibre reinforced composite material properties depending on shape of identified material: plate and beam. Finally, frequency response function approximation method is applied in a study case, where the elastic moduli and Poisson's ratios, of the glass fibre reinforced composite thin plate with $\pm 45^\circ$ fiber orientation are identified, and the influences of plate sizes and calculation step size on the identification accuracy and efficiency are discussed.

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NATURAL FREQUENCIES OF GFRP BEAM UNDER TENSILE AXIAL LOADS

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Keywords: vibration method, natural frequency, axial tension load, composite material

The modern laminated composites materials are widely used as structural elements in civil, aeronautical, marine and mechanical engineering due to its high specific strength and design performance. However, these advantages are balanced by a lower damage tolerance. External mechanical and cyclic loads, as well as changing environmental conditions, can cause the damages in the composite structures, which can greatly degrade their mechanical properties and load-bearing capacity.

The effect of static axial load on the nonlinear vibrations has long been considered an important problem (Evensen, 1974). Having considered vibrations of the beam subjected to an influence of a tensile force directed along its axis, it was revealed the dependence of the natural frequency on the load. With an increasing the tensile force, the frequencies of vibrations increase, whereas a compressive force leads to their decreasing.

However, much less attention has been paid to experimental studies of an influence of tensile force on the natural frequencies and modes of vibrations of a composite beam. This study is concerned with natural frequencies and mode shapes of laminated glass fibre composite beam with $\pm 45^\circ$ fiber orientation under tension in ZWICK testing machine. Axial load is applied by testing machine. Then the natural frequencies are defined by POLYTEC PSV-400-B Scanning Laser Vibrometer. The test beam is excited by a loudspeaker. After the measurement was performed at one point, the vibrometer automatically moved the laser beam to another point at the scan grid, measured the response using the Doppler principle, and validated the measurement with the signal-to-noise ratio. The procedure was repeated until all scan points were measured. The frequency spectrum of the panel was then obtained by taking the Fast Fourier Transform of the response signal.

The investigation shows that the experiment result is closed to the analytical theory: with an increasing the tensile force, the frequencies of vibrations increase.

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RELIABILITY OF REDUNDANT AUTONOMOUS LIFE SUPPORT SYSTEMS FOR DEEP SPACE HABITATION

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Keywords: autonomous transport, life support systems, space missions, reliability models, biotechnology

Ensuring reliability of life support systems (LSS) for long-duration crewed space missions is a critical challenge. LSS provide the critical life sustaining functions of atmosphere revitalization, water recovery, waste recycling, food production, and thermal regulation required for multi-year deep space missions.

The paper goal is to develop a reliability model to evaluate failure tolerance and identify redundancy requirements in an advanced LSS architecture proposed for space transit vehicle supporting a long time crewed deep space mission.

In the paper reliability block diagram (RBD) methodology is used to analyse failure tolerance across different levels and multiplicity of redundancy of LSS architecture.

The RBD approach is applied to model the complex interactions of closed-loop air, water, food, thermal and waste management systems needed to sustain crews far from Earth. Results provide insights into redundancy requirements, single-point failures, and reliability benchmarks needed for candidate LSS technologies to satisfy deep space mission demands.

ANALYSIS OF BMW i3 BATTERY CHARGING PROCESS

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Keywords: battery electric vehicle, HV battery pack, charging station, CCS connector, battery charging

Recently, battery electric cars are rapidly gaining popularity. These cars have many advantages compared to traditional fuel-powered cars, and one of the biggest advantages is less pollution. Electric cars use a rechargeable HV battery pack as a power source, which is charged from the mains. There are several ways of charging, but in all cases, there are some energy losses during charging, and when evaluating the pollution and energy costs of electric cars, these losses should also be evaluated. The purpose of this research is to evaluate the energy losses during the charging of electric car batteries. The BMW i3, a popular battery electric car on the market, was used in the research. It can be charged in two ways - with the help of a Type 2 connector using alternating current (AC) and with the help of a CCS connector using direct current (DC). In the course of the research, natural experiments were carried out, during which the actual electricity consumption of the BMW i3 electric car from the high-voltage battery pack was evaluated. After experimental driving, the battery of the electric car was charged to the initial charge level and, during charging, the actual consumption of electricity from the mains or charging device was evaluated. By comparing the actual electricity consumption evaluated during the experiments from the power grid and the high-voltage battery of the electric car, the charging losses were calculated, and they are set from about 5 to 15 percent depending on the charging method. Experimentally evaluated energy consumption was compared with theoretically calculated results. The experiments performed and the results obtained show that the electric power losses experienced when charging the high-voltage battery of an electric car with direct current electricity (DC) were lower than when charging with alternating electricity current (AC). By comparing the characteristics declared by the battery manufacturer of electric car high-voltage batteries with the results obtained during the experiments, the battery state-of-health (SOH) index was calculated and result was given about 75 percent, which was similar to the one that was obtained with the diagnostic device BOSCH KTS.



Digital Twin Applications

DIGITAL TWIN CONCEPT FOR MANAGING MANUAL SORTING OF MUNICIPAL WASTE

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Keywords: manual sorting, hand sorting, waste management, recycling, digital twin

In recent years, increasing attention has been given to waste management issues. It is mainly related to the promotion of the Circular Economy concept as a key policy objective in EU and beyond (Rejeb *et al.*, 2022). In line with this concept, the aim is to shift from a linear approach (resources to goods to waste) to the circular one, which is based on reuse and recycling. To enable recycling, it is necessary to separate the waste mixture into different fractions. Therefore, it is crucial to consider different waste sorting techniques for the minimal material and quality losses. These techniques can be divided into two groups: manual sorting and automated/mechanical sorting (Wilts *et al.*, 2021). Despite advances in technology and the many new developments that have emerged as part of Industry 4.0, manual sorting is still widely used (Bourtsalas and Themelis, 2022; Lubongo and Alexandridis, 2022). However, the widespread use of manual sorting does not translate into the quantity of research studies in this field.

The manual sorting studies available in the literature are mainly focused on human health and ergonomics. Among them, the risk assessment of work-related musculoskeletal disorders, ergonomic improvement proposals for sorting jobs (Cunha *et al.*, 2020), ergonomic evaluation of work table for waste sorting (Emmatty *et al.*, 2021), occupational exposure to dust, endotoxin and microorganisms (Eriksen *et al.*, 2023) and also health effects of particulate matter (Barkhordari *et al.*, 2022) are considered. There is a definite lack of studies dedicated to the management of the manual sorting. In practice, a retrospective approach is used mainly over a broad time horizon. This makes it impossible to react on an ongoing basis to the highly variable parameters of the sorting process such as change in waste morphology, stream irregularity, stream size. Therefore, it is necessary to develop a method that allows real-time data analysis and optimization of the process. To address the identified research gap, the use of the Digital Twin concept was considered.

In view of the above, the objective of the paper is to present Digital Twin development for manual sorting in the context of its management under variable process parameters. Five stages of research work are introduced. Within these stages, the motion capture gloves for data collection from physical objects (workers) were used. Additionally, simulation model for virtual representation was considered and data exchange system for connection between physical objects and their virtual representations. The issue under consideration in general is part of the ecology field. However, since waste sorting is carried out using a conveyor system (waste is transported between subsequent stream separation points), the problem also qualifies for the area of internal transportation.

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CYBER-PHYSICAL WASTE STREAM CONTROL SYSTEM – A DIGITAL TWIN FRAMEWORK

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Keywords: waste management, waste sorting, recycling, digital twin, framework

With socio-economic development, an increase in waste generation is observed. In view of its negative impact on the environment and human health, it is becoming increasingly important to follow the waste hierarchy. In accordance with it, prevention, re-use, recycling, recovery and disposal are waste management options ranked from most to least recommended. The desirable minimization of waste disposal is undeniably related to effective actions at higher levels of the hierarchy. Especially, it is crucial to maximize the efficiency of separating the waste mixture into fractions which can return to the material cycle in the economy. The separation process is carried out in systems such as Material Recovery Facility or waste sorting plants. These types of systems are characterized by complexity and variability of input waste stream composition (Kleinhans *et al.*, 2021) in terms of physical and chemical features. Therefore, research in this field is usually based on assumed simplifications, limited scope (e.g., only selected system components are studied) and static input-output data. With these, waste sorting systems are studied in terms of modelling (Wolf *et al.*, 2013), designing (technology consideration (Gundupalli, Hait and Thakur, 2017), number and configuration of elements (Ardolino, Berto and Arena, 2017), localization), assessment (technical, environmental and/or economic) (Feil *et al.*, 2016; Abdelhay, Al-Hroub and Al Sharif, 2023) and factors affecting automatic sorting efficiency (Küppers *et al.*, 2020). There is a lack of studies dedicated to a real-time control of these systems. As a result, difficulties are observed in effective management of waste sorting systems. This is reflected especially in the not reaching the required recovery levels by many countries.

With the rise of Industry 4.0, technologies such as the Internet of things, Big Data, augmented reality and Digital Twins have become widespread. In the field of waste management, and more specifically in sorting facilities, these technologies are currently reflected mainly in automatic sorting development (identification of waste fractions using machine learning algorithms) (Erkinay Ozdemir *et al.*, 2021). The high variability of waste morphology and amount, determines the need for real-time stream monitoring for its control and decision-making. The concept of digital twins is in line with the identified problem. Therefore, the main objective of this paper is to present a Digital Twin framework for application in municipal waste sorting facilities.

Three main components required to develop Digital Twin will be presented: a sensor-based waste stream monitoring system, a physical model of the sorting system, a simulation model development and its integration with the physical model.

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FRAMEWORK FOR DIGITAL TWINS CONCEPT IMPLEMENTATION IN INTERNAL TRANSPORTATION SYSTEMS

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Keywords: digital twin, maintenance management, mobile robots

In recent years, the concept of Industry 4.0 and modern technologies based on digitization and virtualization of processes have been extensively analyzed from both scientific and application perspectives. According to (Silvestri *et al.*, 2020) the term Industry 4.0 (P4.0) was first introduced in 2011. The basic premise of this approach is a cooperation between man and machine based on so-called cyber-physical systems, characterized by close interconnection and coordination between networked and physical systems. The main goal is to meet individual customer needs for all phases of the product life cycle (Hermann *et al.*, 2015).

One of the main P4.0 technologies is the Digital Twin (DT). DT is a virtual representation of the actual process. Moreover, it updates the input data in real-time. This makes it possible to detect and eliminate errors (faults) in the virtual system before they occur in the real process (Tao *et al.*, 2019). Therefore, one may predict that this concept can be an effective tool for maintenance management tasks performance, as it helps, among other things, to plan maintenance processes effectively.

Effective maintenance management needs technical skills, techniques, and methods to properly utilize the assets like factories, logistic systems, vehicles, equipment, and machines (Gandhare and Akarte 2012). The main objective is linked to the overall organizational objectives, which should be *to maximize the profitability of the organization by performing activities that retain working equipment in an acceptable condition or return the equipment to an acceptable working condition* (Shenoy and Bhadury, 2003). As a result, the main tasks are connected with (Werbińska -Wojciechowska, 2019):

- ensuring system basic functions (availability, efficiency, and reliability),
- ensuring system life through proper connections between its components (asset management),
- ensuring safety for human operators, environment and the system itself,
- ensuring cost-effectiveness in maintenance, and
- enabling effective use of resources, energy, and raw materials.

A properly designed maintenance management system should be able to cope with these tasks in an efficient manner. At present, there are known classic approaches to maintenance management in the context of, e.g., the use of computerized maintenance management systems. These solutions give the maintenance manager a general overview of the maintenance performance level in the system helping to optimize their activities and making informed decisions (Crisan and Borza, 2018). However, the evolution of CMMS has continued to evolve with the ready availability of technology and requirements (Noor *et al.*, 2021). Therefore, in the context of developing modern information and IT technologies, it seems reasonable to apply the DT concept in the area of maintenance management of technical systems. Therefore, this paper proposes the framework for DT concept implementation in the area of effective maintenance management in internal logistic systems.

As a result, the article presents a short literature review on the defined research area. Later, the main problems in the maintenance management of internal logistic systems are presented. Based on this, the framework for DT concept implementation in the maintenance management area is presented and discussed. The article ends with a summary and directions for further research.

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THE ROLE OF 3D LASER SCANNING IN HISTORICAL BUILDING STOCK ANALYSIS AND ITS CONCEPTUAL DEVELOPMENT BY THE METHOD OF TWINNING ADAPTATION

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Keywords: 3D laser scanning, superblocs, urban research, cultural heritage, BIM technologies

The rapid growth of population in the 21st century and the urbanization of territories have clearly revealed trends of high building and population density, transport infrastructure overload, pollution, and the relevance of urban waste management issues.

These issues are acute in sustainable urban development policies of historical city centers development based on the multifunctional research, its management through a new conceptual approach and digital technologies.

The case of Tbilisi Superblocks analyses, which was developed, based on Twining method of investigation make possible to develop the concept of historical districts development according five key pillars of urban development - social, transport, building stock, governing and historical preservation and thus win the time and organize the surveys in a precise quality and short time. The investigations were developed by the groups of design, technical support, project management and researchers in close cooperation with the implementers of the concept - Tbilisi City Hall and Tbilisi Development Fund and local population.

The implementation of multi-component analysis was hampered due to the lack of time for the project and the large volume of work.

Therefore, the pre-project survey was divided into two phases:

- Selection of the research methodology.
- Research.

The research method was chosen by studying the development of a trial street, where the work was evaluated in terms of time and human resources. It turned out that it was impossible to develop the required urban Cultural Heritage studies using traditional methods within the project budget and timeline. That is why the new approach of investigation was suggested.

This became possible using 3D laser scanning method in urban planning studies, which in a short period of time allowed to gather detailed information on the site - streets and building profiles, facades, cultural monuments; precisely defined public utility areas and interactively transferred this information to design, engineering, social and other groups involved in the project in AutoCAD, Revit, GIS and other requested formats and Systems.

The Historical Districts were investigated through close collaboration of 3D Laser Scanning group with the project leader management units, architects, Urban planners, Art experts, Restorations, structural engineers, transport specialists, etc.

This article illustrates the importance of 3D laser scanning in twinning transformation for urban research in terms of project management – time, human and financial resources; identification of specific problems of 3D laser scanning in urban fabrics, streets, cultural heritage, landscape studies; methods of their solving; the forms and ways of how 3D laser scanning help to create the twinning’s and this technology has supported the creation of a bridge between urban research and BIM technologies in the project and urban design in general.

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Society Transformation

THE SPATIAL PLANNING SYSTEM'S INFLUENCE ON CIVIC PARTICIPATION DIGITAL TRANSFORMATION IN EUROPE

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Keywords: spatial governance and planning systems, digital transformation, public consultation, digital participation, urban communication

Spatial governance and planning systems (SGPS) are methods that governments use to control and guide the development of city land and property rights. According to The ESPON COMPASS study (Nadin *et al.*, 2018), which included 28 EU and 11 non-EU countries, three distinct SGPSs currently dominate in Europe. They primarily differ in their decision-making processes regarding the allocation of unoccupied urban land (Berisha *et al.*, 2021). The paper compares the three most common SGPSs in Europe: The Conformative system, the State-led system, the Market-led neo-performative system depending on the level of civic engagement and the method and digital tools employed for urban communication. This paper reviews the academic literature and categorises the interrelationships among the various key factors: level of citizen engagement; information flow, engagement tools and methods, digital participatory tools depending on SGPS. The analyses are based on secondary data from *The IAP2 framework on public participation* (International Association of Public Participation, 2018; Foroughi *et al.*, 2023), *The Spectrum of Blended Participation* (Akmentina, 2022), and *the functionality of commonly-used digital participatory mapping tools* (Kizika and Akmentina, 2022). Through this analysis, the authors have developed “The taxonomy of factors influencing civic participation digital transformation depending on the Spatial Governance and Spatial Planning System (SGPS)”. There are significant differences between these systems regarding the extent and nature of civic society engagement in the process, particularly in the implementation of modern digital civic engagement tools in the city planning process. These differences have a significant impact on civil rights, specifically in terms of transparency and the ability to influence decision-making processes concerning the allocation of free city land use.

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NAVIGATING ITALY'S GROWING SMART WORKING LANDSCAPE: INSIGHTS FROM EMPLOYEE CLUSTER ANALYSIS

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Keywords: Smart Working, sustainable commuting, logistic regression, Multinomial Logit model, carbon footprint, environmental sustainability

Smart Working is a managerial philosophy based on giving employees autonomy and flexibility in the choice of spaces, working hours, and tools to be used in exchange for greater accountability and responsibility for results and performance. Many companies have adopted a new working approach, especially following the measures to contain the COVID-19 pandemic. As Italy witnesses a remarkable rise in Smart Working, from 570,000 remote workers in 2019 to approximately 3.6 million in 2022, understanding the nuanced influences on the choice of Smart Working days and the significant shifts in commuting patterns becomes crucial.

Our study bridges this knowledge gap, offering a unique two-stage modeling approach that decodes the determinants of Smart Working days and investigates their relationship with commuting choices and environmental sustainability. Our analysis draws on data collected from employees of an Italian company with offices in Milan and Rome. The first stage applies a logistic regression model to identify the factors affecting the choice of Smart Working days. Next, we distinguish these days into categories, incorporating various variables, including individual traits, household characteristics, and job-specific factors.

Subsequently, a Multinomial Logit model is utilized in the second stage to understand the intricate nexus between the chosen number of Smart Working days and commuting mode preferences. This model includes considerations such as commuting cost, time, personal preferences, and the number of Smart Working days established in the first stage.

Our research contributes to the existing literature by exploring how employees' preferences for Smart Working days influence their commuting choices and, thereby, their potential carbon footprint. The insights gathered could provide valuable guidance to companies and policy-makers in developing effective Smart Working policies that consider employee needs and the environment, promoting and facilitating the transition to sustainable digital work practices.

THE IMPACT OF "QUIET QUITTING" ON OVERALL ORGANIZATIONAL BEHAVIOR AND CULTURE

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Keywords: quiet quitting, digital culture, organizational behavior, post-covid culture, workplace

Global productivity is on the line, mainly because developing customer relationships run through the workplace. Whether "quiet quitting" is a trend, or a real thing requires severe consideration and assessment. Organizational behavior and culture are essential in the era of rapid change and sustainable development. Integrating employees into a digitally ready future labor culture is crucial. Today, people are tired of being someone at work they are not, suggesting that this trend is not only harming the workplace, thus making all of us more conscious of why the "traditional" workplace has never worked. This article recognizes that the labor market was never fair; however, employers need to build on the culture that makes people want to stay and hire candidates based on their character. With a systematic review, this research aims to define and explore "quiet quitting" and its impact on organizational behavior and culture. The authors have an opportunity to interview 27 respondents who practiced and continue practicing a "quit quitting". It must be noted that the average work experience of respondents was nine years. Therefore, 12 exclusively designed questions were asked to obtain evidence about the reasons behind this trend. This allowed the authors to contribute to the scholarship on the knowledge gap into "quit quitting". The results of the research showed that there is a significant relationship between "quit quitting" and organizational behavior and culture. Hence, four major patterns were discovered in the study that impacts organizations' behavior. One of the significant findings highlighted was that managers must establish liability for individual performance, team collaboration, and customer value. Moreover, employees must see how their efforts contribute to the organization's bigger purpose to avoid "quiet quitting".

DRIVERS OF SPORTS GLOBALIZATION AND COMMERCIALIZATION

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Keywords: sports club, globalization, commercialization, sports ecosystem

Sport today plays a significant role in society on global scale; it has changed the emphasis of what cultural distinctions are important (Maguire, 1999). Modern sport is connected with a global network, which is characterized by the international movement of all types of capital: human, technological/industrial, financial, informational, intellectual, and therefore has an economic dimension. The attractiveness and popularity of sports enhances the commercialization of sports and affects cities, regions, countries and the international community. The commercialization of sports is closely related to the search for talent and investments in both human capital and infrastructure in order to promote their own brand and extract more profit (Bouchet *et al.*, 2013). The mass media, providing informational and financial support to sports clubs in promoting their brands and acquiring a global audience, contribute to the fact that a sports club transforming into a business unit, becomes interesting for commercial stakeholders. Their money, time and passion are the cornerstones for this intensified commercialization (Winell *et al.*, 2022).

The aim of the paper is to determine the factors contributing to sports globalization and sports commercialization. Research objectives are: 1) examine models that include interrelated political, economic, cultural and social aspects that determine the forms and trends of modern sports; 2) analyze the evolution of the development of sports models under the influence of the commercialization of sports brands; 3) identify the factors that shape the global sports ecosystem and are the driving forces of globalization and commercialization of sports. Developing this paper, the authors performed a structured literature review of available scientific publications between 1999 and 2023 that all focus on how sport industry are affected by the globalization and commercialization. The study contributes to the theoretical aspects of sports clubs' internationalization and formation of a global sport ecosystem. The structured literature review allowed the authors to conclude that due to the expansion of the influence of media communications and the strengthening of the role of sports in society, the sports club is turning into a communication channel that focuses on the global market, corporate management and sponsorship.

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THE IMPACT OF USER-GENERATED MARKETING ON CREATING GREATER AUDIENCE CONNECTIONS AND BRAND LOYALTY

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Keywords: user-generated data, sustainable marketing, content marketing

In times of rapid change and sustainable development in marketing, user-generated marketing has gained a considerable advantage as a powerful marketing tool to attract and interact with various targeted audiences. UGC gives customers a unique opportunity to participate in a brand's growth. Hence, it creates a bridge between a brand and a customer, resulting in developing and increasing engagement with audiences. Furthermore, it establishes a sense of community between the brand and the audience. As UGC is an excellent way for businesses to create buzz about the brand, the study aims to demonstrate the impact of user-generated marketing on creating more incredible audience connections and brand loyalty. The authors used a three-step approach to research. First, systematic secondary research was used to explore and analyze available materials. As a result, 71 scientific articles and reports were carefully chosen based on excluding criteria. Second, a survey study was developed in which 157 marketing practitioners participated and willingly provided feedback on select questions. Lastly, the study was conducted on a company using UGC strategies to build relationships between audiences and brands. The obtained information was then synthesized and used to develop recommendations. Finally, the authors bring Media Mix Modeling to demonstrate how marketers measure the impact of UGC to determine how various elements drive audience conversations. The results of this research are exceptional as it enables marketers to hone their campaigns based on actionable guidelines that assist in transforming user-generated content into more engagement and conversations with the brand. Brands that incorporate the power of UGC in their marketing operations can construct a more pertinent relationship with future audiences.

ROLE MODEL FOR INDEPENDENT SURVEYORS DURING THE COVID-19 PANDEMIC AND SIMILAR CRITICAL SITUATIONS

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Keywords: maritime transport, logistics intermediaries, independent surveyors, Covid-19 pandemic

COVID-19 was first recorded at the end of 2019 in the Chinese city of Wuhan, and already in 2020 March 11 The World Health Organization has declared a pandemic. Due to the rapid spread of the infection, the governments of many countries around the world have decided to implement measures to limit the spread of this virus. In addition to being primarily a healthcare crisis, COVID-19 has also had a significant impact on the economies of countries around the world. In a world where almost all economic activities are interconnected, a new business disruption can have far-reaching consequences for all entities involved. The global maritime transport sector has also been significantly affected by the COVID-19 pandemic. Due to the measures introduced by governments to combat the spread of the pandemic, ports began to lack equipment, the number of working personnel decreased, some cargo transportation routes were closed, cargoes began to be delayed, and work in port terminals, warehouses and distribution centres was compromised. Many containers were stuck, resulting in increased fines for cargo delays. The work of port services has also changed.

The impact of the COVID-19 pandemic on supply chains was investigated by Hobbs (2020), Araz *et al.* (2020); Ivanov and Dolgui (2021) and others. Pandemic risks to supply chains were studied by Ivanov (2020). The impact of COVID-19 on maritime transport has been studied by Cullinane and Haralambides (2021), Kumar and Jolly (2021) and others. The impact of the pandemic on port operations was studied by Menhat and Zaideen (2021); Koyuncu *et al.* (2021).

The COVID-19 pandemic also affected the work of independent surveyors (it became more difficult for them to carry out inspections and access ships). Akyurek and Bolat (2020) studied changes in the activities of independent surveyors in ports. They analysed the role of independent surveyors in the context of logistics supply chain restructuring and the appropriate actions taken during and after the pandemic. However, there is a lack of research that provides a model of independent surveyors' activities during the pandemic, which could be applied to other similar situations that cause disruptions in logistics chains and negatively affect port operations.

Article presents a review of the new circumstances that affect working conditions of independent surveyors and aims at providing their activity model corresponding to the new challenges. The main research subject is performance of independent surveyors in the new conditions, while the main question addressed in this research is “what performance model of independent surveyors should be taken in order to adapt to changed circumstances and conditions”? The main results of the article are obtained through the analysis of scientific and thematic literature as well as results of the survey of respondents representing the sector of independent surveyors.

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Digital Economy and Business

THE IMPACT OF ESG ON PERFORMANCE OF LATVIAN COMPANIES LISTED ON BALTIC STOCK EXCHANGE

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Keywords: ESG, corporate sustainability, company performance, Nasdaq

One of the key goals of stock exchange is to foster environment where all its participants – investors, regulators, companies – can be involved sharing economic opportunities were also the ESG (environmental, social and governance) reporting plays crucial role to ensure more successful move for companies listed on Baltic stock exchange during the process of global transition to more sustainable economies. Moreover, it reinforces more transparent and efficient market to all stakeholders.

Therefore, the *key goal* of this research paper is to analyse existing ESG requirements, practices and ESG reports of Latvian companies listed on Baltic stock exchange and investigated whether there is any mutual relation between corporate sustainability performance and performance of these companies.

Main tasks were:

- to investigate Nasdaq Riga ESG requirements for Latvian companies listed on Baltic stock exchange and analyse existing approaches in all Latvian companies listed on Baltic stock exchange per period from year 2017 to year 2021;
- to investigate whether there is any mutual relation and impact between companies' ESG practices and its performance.

The study includes a sample of 27 Latvian listed companies on Baltic stock exchange representing 9 industrial sectors in year 2017 to 16 ones representing 10 industries in year 2021. The secondary sources of information available at the Nasdaq Riga website were used. The research paper is based on the analysis of theoretical literature and research papers within the area of information provided in companies' financial statements and existing ESG reporting practices.

The findings of this research paper shows that according with rules defined by Nasdaq Riga Latvian companies listed on Baltic stock exchange are being allowed to develop and report the ESG report on a voluntary basis. ESG reporting guidelines defined by Nasdaq Riga do have a recommendatory nature rather than mandatory rules.

Furthermore, it was explored that there are positive effects of the ESG practices on performance of Latvian companies on Baltic stock exchange. This supports the significance of the ESG reporting of these companies during the process of global transition to more sustainable economies.

Moreover, results of this research provide insights for the companies' management and other stakeholders regarding prioritizing necessary resource related ESG activities because these activities do have the impact on companies' performance.

The results of this study contribute to the nowadays growing literature on financial implications of the ESG performance disclosures and might be of interest of academic researchers as well as educators and practitioners.

ENHANCED ECONOMIC SUSTAINABLE EVALUATION OF OPERATIONAL PLANNING IN INDUSTRIAL ENGINEERING COMPANIES

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Keywords: total logistic costs, integrated planning, budgeting and operating planning, sustainability evaluation, digital-twin, artificial intelligence

Classical approaches of supply chain management focusing on solving the contradicting objectives in the “dilemma of operational planning”, described as the “magic square”, and they are built on costs and service quality aspects. With the rise of sustainability considerations as well as with smart concepts, these approaches were transformed into advanced models including integrated sustainability dimensions. The high degree of integration of modern companies supports the holistic view of the supply chain management (SCM) process, and require much more precise approaches on control procedures, considering analysis as well as synthesis of functions, targets, and management parameters. Pragmatic solutions to solve this challenge in volatile, uncertain, complex, ambiguity and dynamic (VUCAD) environment, are based on finding an effective combination of failure prevention and safety philosophy as well as uncertain, chaotic trial and error culture. Such practise is powerful in solving tasks of the operative management but shows its limitations in activities of organisational development and strategic management as well as alignment of budgeting and operational planning, which is reasoned in the different mind-set in solving these decision situations.

The aim of the research is to outline an appropriate analytical model within a conceptual framework, so that it can be used for solving contradicting objectives in operational planning, as well as fulfil tasks in budget planning and give guidelines for management tasks in the logistic functions. First it was split the complex tasks of holistic planning into smaller steps, which allows to analyse separately the logistic functions and therefore dimensions of supply chain, and manage them by setting targets, design actuating variables and manage control variables using the parameter of the Total Logistic Cost (TLC) modelling approach. With this modelling approach it is shown how to determine and to manage complex reciprocal dependencies between the actuating variables of the logistic function and the targeting in the operational planning as well as the control variables used as measures in the budgeting process. Therefore, the analytical measuring and optimizing task turns into a management assignment, which shows the limitations and challenges of present Artificial Intelligent (AI) and Machine Learning (ML) solutions. This approach enriches additionally the understandings of smart data in digital-twin solutions, and it is a conceptual basis for artificial learning theory, as it may serve as a framework for optimization and simulation-oriented software advanced solutions. Since the authors were involved in several sustainable transportation projects with a special focus on management solutions for the logistic companies with fleets, the developed model is empirically validated in the context of sustainable supply chains.

DEVELOPMENT OF A TECHNICAL SOLUTION CONCEPT FOR PROCESS AND DATA MINING IN ORGANIZATIONS FOCUSED AND APPLIED ON E-MAIL PROCESSES

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Keywords: process mining, data mining, support vector machine (svm), decision-making, artificial intelligence in management

This paper embarks on a transformative exploration of decision-making paradigms in contemporary organizations. It presents an incisive study into the compelling dichotomy between traditional and Artificial Intelligence (AI)-enhanced methodologies. The initial part of the investigation brings to light the instrumental role of process and data mining in effective business operations management. By illuminating their significance, the paper sets the stage for a deeper investigation into how these tools can be used to drastically improve organizational efficiency and decision-making processes.

The significance of process mining and data mining in organizations is elucidated initially, underlining their instrumental role in the efficacious management of business operations (van der Aalst, 2011). The paper then proceeds to implement process mining methodologies on an anonymized dataset of e-mails, crafting a dynamic business process characterized by continual metrics analysis and supervision. This approach underscores the potency of process mining in delivering actionable insights from complex datasets, significantly improving operational efficiency (Dumas *et al.*, 2018).

Subsequently, the paper presents the application of data mining via Support Vector Machine (SVM) on the e-mail data. SVM, a prominent machine learning algorithm, is known for its robustness in high-dimensional spaces and effectiveness in classification tasks (Cortes & Vapnik, 1995). Leveraging this, the study demonstrates the profound potential for automation, offering a tantalizing glimpse into future organizational operations.

Through this dual-pronged examination of process mining and SVM-based data mining, the paper illuminates the transformative potential of AI in redefining decision-making processes in management. It underscores the capabilities of AI to transcend traditional boundaries and catalyze a new era of data-driven, automated decision-making.

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WATER TRANSPORT ENTERPRISES COMPETITIVENESS ESTIMATION MODEL

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Keywords: water transport, enterprises, competitiveness, mathematical modelling

The transportation system ensures the functioning of the country and its local and international connections. The activity of the water transport sector, whose functioning significantly influences the country's competitiveness, requires additional research, the development of scientific and applied tools for assessing the competitiveness level of enterprises in this sector, and the justification of mechanisms for its enhancement.

The aim of the article is to develop water transport enterprises competitiveness estimation economical – mathematical model.

The provided water transport enterprises competitiveness estimation economical – mathematical model covers economic, social, material and technical, geographical external environment aspects as well as additional: innovation and information support, organizational and managerial ecological infrastructure internal enterprise aspects.

In terms of economic factors, the research analyse financial indicators such as profitability and return on assets, indicating the financial performance of the enterprises. It also discusses the level of investment attraction and the enterprises' share in the water transport cargo turnover. These factors are crucial in assessing the economic competitiveness of the enterprises.

The social aspect is addressed through the examination of wage levels, labor productivity, and the enterprises' contribution to employment in the local population. The research highlights the wage disparity among different enterprises and the impact on labor productivity. These social factors have implications for the overall competitiveness and well-being of the workforce. The material and technical component focuses on the capacity and capabilities of the enterprises, including the ability to handle vessels of varying draft, length, and width. It also considers the utilization of fixed assets and the effective use of resources. The text emphasizes

the importance of efficient infrastructure and equipment to enhance competitiveness.

The geographical component explores the location of the enterprises, their connection to international waterways, and their participation in regional organizations. The research highlights the geopolitical advantages of the regions, such as its proximity to major waterways and its role in regional cooperation initiatives. It also mentions the challenges posed by the region's climate.

Developed model is based on international experience in water transport enterprises competitiveness model's development (Peng *et al.*, 2018; Wiegmans and Konings, 2015).

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DIGITAL CONNECTIVITY AND INCREASE IN LABOR PRODUCTIVITY: A CASE STUDY OF SUB-SAHARAN AFRICAN COUNTRIES

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Keywords: digitalization, labor productivity, intra-sectoral component, inter-sectoral component, re-allocation channel

Digital technologies have experienced a strong expansion in sub-Saharan Africa. This leads to a digital transformation of the economies of this region, which is now one of the places in the world where these technologies have met with great success in terms of their implementation in business settings. Digital connectivity – the ability to adopt and use them efficiently – has greatly improved in recent decades with the arrival of submarine cables in 2009. Sub-Saharan African countries have seen the quality of their internet network improved considerably. According to GSMA (2019), compared to other regions in Africa, Sub-Saharan Africa has the fastest pace of progress in terms of adoption of mobile technologies, with an annual growth rate of 33%. At the end of 2018, the sub-Saharan Africa region experience an increase of 20 million unique mobile subscribers compared to the previous year and the penetration rate of 44%. Around 23% of the population utilize mobile Internet on a regular basis as well. The Sub-Saharan Africa remains the region with the highest growth rate, with a compound annual growth rate of 4.4% and 167 million additional subscribers by 2025.

It seems obvious that digital technologies can be an important factor for the growth of factor productivity. Issues of factor productivity occupy an important place in research in economics, insofar as productivity increase is the founding element of the improvement of real incomes, growth, and well-being. Previous IMF (International Monetary Fund) Studies have found that productivity growth and its sustainability is negatively affected by income inequality (as measured by Gini coefficient) especially relevant for developing countries (Ostry *et al.*, 2014). It is therefore important to examine the sources of productivity growth, especially for developing countries and those of sub-Saharan Africa in particular, due to the delay they experience compared to other regions of the globe.

This research aims to explore the impact of digital connectivity on the economies of sub-Saharan African countries. The related objectives include the following: 1) to discuss the digital connectivity phenomenon as a source of labor productivity gains; 2) to find out whether it promotes Lewis-type labor movement between different sectors; 3) to examine the dependence of labor productivity on two components – an intra-sectoral component and inter-sectoral component. The following research methods are applied: 1) using the shift-share method of McMillan and Rodrik (2011), an analysis is performed that breaks down the growth of approved productivity into the two components; 2) using an endogenous growth model, the ordinary least squares technique is employed to understand the resource reallocation channel induced by digital connectivity. The research focuses on a sample of 18 countries in sub-Saharan Africa due to the availability of data on sectoral labor productivity. The study is based on the estimation period of 28 years from 1990 to 2018; the database on economic transformation of “Groningen Growth and Development Center (GGDC)” containing 12 sectors is utilized.

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INCREASING THE SIGNIFICANCE OF THE COMPANY’S INTEGRATED REPORTING TO INVESTORS IN THE FINANCIAL MARKET

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Keywords: integrated reporting, performance, capital involved, investors

This article reveals the importance of integrated reporting (IR) in the context of a company sustainable development. Integrated reporting is an extension of traditional corporate reporting, providing interested users with information about how an organization creates value over time using all types of capital involved. This article focuses on the examination of leading practice of preparing an integrated reporting in accordance with the content recommended by the Integrated Reporting Framework for the best understanding of the relationship of financial indicators with the company's strategy and corporate value creation process. A qualitative analysis of the integrated reporting of the case companies was conducted to determine the main drivers of the companies' value and its impact on the changes in value of different types of capital used. The goal of this article is to examine how the structure of integrated reporting is formed, which ensures transparency of information for users and enhances the significance of such type of reporting in the eyes of investors. The publication of the company's integrated reporting strengthens the confidence of shareholders in this company, enhances the attractiveness of the company's shares in the stock exchange. This allowed the authors to conclude about the increasing significance of the company's integrated reporting to investors and positive reaction of the financial market to its publication.

TALENT MANAGEMENT PERFORMANCE ASSESSMENT IN THE DIGITAL ECONOMY CONTEXT

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Keywords: human resources, talent management, employee turnover rate, performance assessment framework, digital solutions

Nowadays, companies compete for competent and skilled human capital. For maintaining competitiveness in the context of the digitalization of economy, modern companies should attract and retain top talent. Human resource management encompasses Talent Management and Performance Management. Performance management optimizes individual performance, aligns with organizational strategic goals, and includes employee performance assessment. Talent Management is regarded as a process used by companies to optimize how they recruit, train and retain employees. Having Talent Management in place, companies can improve employee satisfaction, retention of top talent, accomplishment of financial goals, employee productivity, and innovation. By paying attention not only to employees' performance and potential, but also to developing and using talent in the best possible way, firms can prolong the employee lifecycle, maximize returns, and meet their investments.

The aim of this research is to develop a framework for employee performance assessment to prevent employee turnover intentions. The research focuses on the employee performance assessment framework as the subject. The object of the research is talent management in the private sector.

The following research tasks are formulated: 1) to investigate the role of Talent Management assessment in the HRM policy of a company; 2) to compare different employee performance assessment methods and digital solutions applied for effective employee performance assessment; 3) to identify a set of criteria for employee performance assessment in Talent Management to be applied in the framework for employee performance assessment aimed at improving Talent Management policy in a company.

The research results would contribute to the development of new metrics for employee performance assessment used for preventing employee turnover.

COMPETENCY MODEL AS A FACTOR IN THE SOCIAL DEVELOPMENT OF THE ENTERPRISE

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Keywords: competence, key components, social development, enterprise, stakeholders

Currently, the construction of corporate competency models plays an important role in the human resource management policy of modern enterprises. In some companies, competency profiles are used as applied tools, while in others, the system of prescribed competencies is the key in working with personnel. The use of competencies in personnel assessment is particularly widespread. Exactly the use of this tool allows hiring managers, when evaluating the performance, to analyze not only what was achieved by the employee over the past period, but also how it was done. This dictates the relevance of the study. The aim of the article: having analyzed which competencies are of interest for modern companies and researchers, for whom the social component of society development is important, to propose unified new competencies. The article draws on the work of authors such as: Robert W. White, Richard Boyatzis, Jonathan Winterton and others.

It should be noted that Boyatzis formulated a new definition of competence, which remains relevant to many researchers and HR specialists today. According to him, competence is "an underlying characteristic of a person which results in effective and/or superior performance in a job". Competence includes motives, skills, vision of self, social role and knowledge. (Chouhan, 2014)

Thus, it can be concluded that competence is a specific area in which a person is well informed, has practical experience and demonstrates a willingness to perform activities independently, and competence is an integrated characteristic of personal qualities, acting as a result of the graduate's training to perform activities in certain areas.

The result of the analysis is the presentation of 11 new competencies, which will be further submitted for evaluation to employers from the areas: logistics, consulting, financial services, trade, heating industry and education.

The general recommendation is that each enterprise, when creating a competency model, should take into consideration not only the internal environment situation, but also other significant elements, such as: the level of economic development of the country, the state and prospects of the labor market, sociodemographic factors and national peculiarities of management.

It can be said with confidence that the own model of competencies will allow the company to introduce the practice of long-term planning and forecasting of necessary human resources, and also quickly and effectively form the personnel reserve.

The result of the corporate competency model creation process could be individual competency profiles, which would be developed and correspondingly relevant for each position. In the next step, this will make sure that the competencies correspond precisely to all the job roles that are declared in the company.

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PROSPECTS OF LENDING DEVELOPMENT IN LATVIA: PROBLEMS AND SOLUTIONS

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Keywords: bank lending, credit risk, banking business, efficiency, liquidity

The development of the banking business is limited by the shortage of high-quality borrowers and the level of capital to cover growing risks. These factors lead to an excess of low-yield liquid assets, which increase the pressure on the profitability of a significant number of banks. The share of Latvian commercial banks with low-yield liquid assets and an inefficient business model is increasing. Increasingly, the crisis of business models is faced with average banks in terms of assets, which leads to a decrease in their presence in the market. The potential to increase bank profits from lending to the real sector of the economy is significantly limited by weak economic growth and increased capital requirements to cover credit risks. The excess liquidity generated by the lack of high-quality borrowers increases the pressure on the profitability of the banking business. Due to the limited base of high-quality borrowers, more and more banks are forced to place client funds in highly reliable but low-yield assets. However, despite this, the credit portfolio of the Latvian banking system tends to grow, showing positive dynamics. The situation with credit risks in the banking system has stabilized. The level of overdue debt on loans is decreasing and there are positive trends in the issuance of new loans. The purpose of the study is to analyze and assess credit trends in Latvia, as well as predict the development of the Latvian credit market using the extrapolation method. The results of the study can be used by commercial banks, as well as their borrowers.

EVALUATION OF SUSTAINABILITY AND EFFICIENCY IN BANKING SYSTEM OF LATVIA AND GEORGIA

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Keywords: banking system, sustainability, efficiency, capital safety margin, capital adequacy

Global financial integration encourages close international cooperation and encourages various local banking systems to interact with each other. This leads to the need to evaluate and compare individual banks and banking systems of different countries. So, as cooperation between the countries develops, cooperation in the financial and banking sector also increases. Despite the fact that the banking systems of various countries are developing depending on national characteristics, in global economic cooperation, commercial banks need to ensure their activities in accordance with the factors of influence of general trends in the global economy. In the article, the authors consider the relationship between the stability and profitability of the banking systems of Latvia and Georgia, identify factors affecting the capital adequacy and profitability of banks in these countries. The purpose of the study is to identify the consequences of banking regulation in the countries under analysis and to predict the sustainability of banking systems based on the safety margin of capital. The results of the study showed the possibility of comparing the stability and profitability of banks operating in different economic conditions. Thus, capital adequacy in the Latvian banking sector is higher compared to the banking sector of Georgia. But at the same time, the safety margin of capital in the banking sector of both states is sufficient to carry out activities. The novelty of the study is that for the first time an analysis of the comparison of the functioning of the banking systems of Georgia and Latvia was carried out, and the level of stability of these banking systems was predicted based on the safety margin of capital.



Modern Trends in Higher Education & Research

USING THE TRANSFORMATIVE POWER OF ARTIFICIAL INTELLIGENCE IN THE MANAGEMENT OF A MODERN UNIVERSITY

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Keywords: university, digital transformation, AI-driven solutions, educational process, administrative management, academic management

Artificial Intelligence is widely used in multiple fields in the context of the digital transformation of economy and society at large. In business, AI-driven solutions are becoming indispensable. However, in education, it also has a big potential to address current challenges, revolutionizing teaching and learning practices and accelerating progress towards UN Sustainable Development Goal 4 – “quality education”. AI has the capacity to transform the conventional teaching and learning methods technologically, as well as to transform the existing management systems that deal with various administrative operations at the institutional level. The three aspects, which should be considered when discussing the use of AI-driven solutions at a university, may include application of AI in educational process, as well as application of AI in both administrative management and academic management.

The aim of the study is to explore the attitudes of students, academic and administrative staff to using AI-driven solutions in higher education for enriching learning and teaching experience and improving operational efficiency of a university.

The paper examines a few examples of how universities implement AI-based technologies for enhancing organizational capabilities. A survey was conducted among students, teachers and administrative workers of Transport and Telecommunication Institute to find out what issues demand a special attention of educational managers in the agenda of using AI in a modern university.

The paper is supposed to contribute to understanding of the main challenges faced by university management and staff in the context of using potential benefits of AI in higher education.

ARTIFICIAL INTELLIGENCE AS A TOOL FOR HUMAN- MACHINE PARTNERSHIP IN THE EDUCATIONAL PROCESS

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Keywords: artificial intelligence, request, competencies

The active integration of artificial intelligence (AI) into all dimensions and elements of educational activities defines the latest stage of digitalization of educational institutions and practices. At the previous stages, digital technologies were mainly used as supporting tools assisting teachers and students and integrated into traditional teaching models while preserving and expanding the didactic capabilities of the educational process. Using AI implies substantial changes in the very nature of educational activities. Today, we can already say that various human-machine partnership practices will increasingly be at the core of educational activities, with AI playing a leading role in education.

Alongside the traditional subjects of the educational process – teacher and student – a new, third subject emerges on an entirely equal basis, namely artificial intelligence, primarily in the most accessible form of chatbots. Consequently, there is a need to search for and develop effective methods and technologies for interacting of these three subjects within the human- machine partnership. Several factors significantly influence the quality of this partnership: the level of capabilities of a specific neural network, the functions delegated to it by humans, as well as preparing human resources for the education system, etc.

The main goal of this research is to determine ways of constructing high-quality requests to AI as the key element of human-machine partnership considering that the most complex requests are in the form of dialogue/polylogue between the mentioned subjects of the educational process. It is also about increasing the effectiveness of instructing based on models and practices of collaborative learning considering the previous authors’ research (Kazinski & Puptsau, 2023; Miniankou, 2021; Miniankou & Puptsau, 2023). The authors conclude that utilizing the capabilities of AI allows moving away from the “one size fits all” approach in education and proposes instructional tools, which personalize learning and adapt to individual needs and abilities. The quality of requests becomes a key means of such individualization and personalization serving as a foundation for intelligent tutoring systems.

From the perspective of the educational process, this means enhancing its research aspects. The ability to ask meaningful questions to a chatbot, questions that induce desired answers, likely represents the most crucial competency that needs to be continuously fostered, particularly considering its lifelong learning orientation. It should also be noted that requests to AI not only expand the typology of search queries previously performed on the internet (Mahdi, 2021) but also require a high level of cognitive thinking skills among all learning subjects due to their heuristic component and logical-argumentative dialogue. Our retrospective analysis of students' abilities to engage in such dialogue reveals a low level of such competencies. This paper, considering empirical research, explores ways and methods of forming competencies for the effective using AI, necessitating the preparation of appropriate methodological manuals and recommendations for teachers and students.

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DIFFERENCES IN RESEARCH PERFORMANCE BETWEEN CENTRAL ASIAN AND BALTIC STATES

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Keywords: transition economies, research performance, Central Asia, Baltic states

This study aims at comparing Baltic states and Central Asia in quantified indicators of scientific research. It then makes an attempt to explain the substantial differences between the two distinct regions from the perspective of liberalization and modernization in the academic sectors of the respective transition economies. Despite the shared background of newly independent states, a notable discrepancy in absolute and especially relative measures of research productivity and impact became apparent during the past three decades since 1991. Liberalization, reforms and proximity to the leading countries in research are interconnected factors capable of determining the performance gap. The analysis of indicators from related databases of governance and publishing suggests corresponding improvements demonstrated by Latvia, Lithuania, and Estonia, which is particularly notable relative to Turkmenistan, Tajikistan, and Uzbekistan (Clarivate, 2022, SJR – SCImago, 2022). Kyrgyzstan and Kazakhstan, while achieving higher performance in certain indicators compared to the other Central Asian states with less liberalized conditions, still made slower progress in relative measures compared to Baltic states. Insufficient autonomy, internationalization, and academic freedoms could exacerbate the problems in the post-Soviet academic sectors caused by issues with funding, English proficiency, aging staff, and transparency (Ovezmyradov and Kepbanov, 2022). Furthermore, inadequate reforms could contribute to questionable academic practices. Similar to Baltic counterparts, Central Asian states could complement economic liberalization with bolder steps towards greater socio-political liberalization in order to modernize the academic sectors in the current situation. Greater participation of Central Asian researchers in international projects and conferences (such as RelStat-2023) can contribute to bridging the gap and improving the research impact, productivity, and global ranking.

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STUDENT ACADEMIC SATISFACTION SCALE (SASS): DEVELOPMENT AND VALIDATION

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Keywords: measurement of satisfaction, students, academic satisfaction scale, SASS, measurement metrics

In the contemporary educational environment, where rapid changes in labour market demands and the development of digital technologies pose new challenges to educational institutions and students, the study of student satisfaction gains particular attention. This is understandable, as the enhancement of education quality, increased effectiveness, and the competitiveness of educational programs remain top priorities (Latvijas nacionālais attīstības plans 2021.–2027. gadam, 2020; Student-centred learning: approaches to quality assurance, 2019). A high level of satisfaction can lead to the creation of a positive image and an enhancement of an institution's reputation, which, in its turn, can attract a greater number of potential students and even result in additional investments and funding.

Using a reliable tool to assess student satisfaction plays a crucial role in identifying key areas for improving educational programs. Understanding the factors influencing academic satisfaction is essential for educational institutions aiming to enhance their programs and support mechanisms effectively. Nevertheless, existing methods for collecting and analyzing data on student satisfaction with the educational process often prove to be unreliable, thus limiting the possibilities for comparative data analysis among different educational institutions (Alderman *et al.*, 2012; Kane *et al.*, 2008; Nogueira *et al.*, 2019; Sisto *et al.*, 2008).

The aim of research was to develop and validate the Student Academic Satisfaction Scale (SASS) - an integrated questionnaire specifically designed to assess and compare students' satisfaction indicators among recipients of educational services in an educational institution. The development of this scale aimed to provide reliable measurement metrics and simplify its use for both researchers and students.

The study was conducted from 2021 to 2023, with the participation of 657 students. Student surveys were conducted on a voluntary basis, with strict adherence to the principles of anonymity and data confidentiality. All research procedures complied with ethical standards and data protection policies (GDPR).

A study has been conducted in which sufficient reliability and internal consistency of the provided statements have been established. This confirms that the data collected and analyzed within the study can be considered reliable and coherent. Furthermore, metric measurements and descriptive statistics are presented in the report, allowing for a more in-depth examination and analysis of the obtained results and their variability. These data serve as important tools for further interpretation and utilization of the research findings.

The advantages of this SASS include its ability to assess the level of overall academic satisfaction of students, as well as to identify individual 9 aspects related to the educational process, teaching, assessment system, teacher support, availability of study resources, student mobility, organization of educational events, interaction with fellow students, taking into account the opinions of students, etc. In addition, SASS makes it easier to compare the results of a survey of students of different educational programs, forms and years of study.

The author expects SASS to become a useful tool for educational institutions, helping them improve the educational process and quality management system.

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THE NEW AXIOMS OF MEDIA EDUCATION, BETWEEN ALGORITHMS, MASS SURVEILLANCE AND INCLUSIVITY PROTECTIONS

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Keywords: media education, data protection, AI

The digital transformation (Calveri *et al.*, 2021) that has swept global society, imposes reflection and revision that inevitably impacts multiple dimensions of life, educational models (De Giuseppe, 2018), ethical canons (Benanti *et al.*, 2021), economic models (Alessandrini *et al.*, 2020) and the protection of personal rights: privacy protection (Trezza, 2020) and the guarantee to accessibility, from an inclusive perspective and the welfare for people (Morin, 1999). The digital era consists of a transformative impetus that is expressed in a metamorphosis of the of work organisation and social patterns and implies the research of points of connection between digital technologies, human and organisational factors, deeply reflecting on the sustainability and social values. Basically, the digital future's spirit is to offer help and well-being to each individual (De Giuseppe, T. *et al.*, 2021). However, this approach should have assumed the central role of the privacy of the individual who would hold the exclusive rights to their data when they decided to digitise them. This was not the case; on the contrary, the right to privacy, knowledge, and the use of sensitive data risks of being usurped by artificial intelligence: in fact, the information society through digital feedback actions can put man in a condition of control by the algorithmic machine, placing society in a sort of mass surveillance (Proposal, 2021). The system becomes the data holder, appropriating human experience and using it to know future behaviour, using and exploiting the ignorance of the masses. Institutions are moving to contain the possible repercussions of the AI systems on the fundamental rights of the individual (Severino, 2022). A comprehensive and organic regulation of AI is needed in order to seize the opportunities of an unstoppable development by moderating the negative consequences through appropriate boundary and regulation, directing the progress of the AI towards and for human development and not only for progress for its own sake. If what society is experiencing now is only the beginning of the dramatic potential of artificial intelligence, in addition to legislative regulation there is an urgent need for media education. Young people who will be the protagonists of this scenario, considering their educational background, will have to develop all the appropriate skills to live or at least coexist in an increasingly digital age. There is therefore an urgent need for a kind of digital education, a digital literacy that must guide future generations. We chose to analyse a virtuous example, Decidim Barcelona (Aragón *et al.*, 2017) a platform that aims at fostering both collective and democratic participation in institutions and citizen proactivity, and uses data for the ultimate purpose of the common good, even if some doubts about the impact of algorithmic decision-making on individual and collective outcomes remain (Bak- Coleman *et al.*, 2021). The vision arises from a reinterpretation of the two concepts explained by two different authors, that concerning the digital sustainability (Benanti *et al.*, 2021) and that on surveillance capitalism (Zuboff, 2019): the digital bomb is exploding, and organic regulation and education are two indispensable voices for generative AI, oriented toward the common good and inclusive (Boca *et al.*, 2016) prosociality (De Giuseppe, 2020) by making use of educational models for building an accessible community (Sibilio *et al.*, 2015). The phenomenon has been investigated through the systematic review of the literature, and a qualitative-quantitative research project is currently being implemented at the Giustino Fortunato Telematic University, with a view to promoting

well-being and to detect how the phenomenon of digital transformation affects the working and private lives of individuals and whether through the help of platforms it is actually possible to hope for synergistic work between institutions, with the proactive participation of citizens. To this end, about 250 public administration employees enrolled in the Valore P.A. Training Courses provided by Giustino Fortunato University will be involved in the research.

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eMediator Project Session

MOBILITY EDUCATION AS A SERVICE: GENERAL CONCEPT, MODEL AND DEMO PORTAL

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Keywords: education ecosystem, digital platform, Education as a Service, DEMO portal, system components models

The modern digital economy is characterized by high dynamics of changes in the working environment based on information technology. This creates new requirements for the qualifications of employees, makes them constantly retrain to acquire the appropriate competencies, combining the process of work and learning.

This requires a new, more flexible, and accessible educational environment with access to education at any time without the physical movement of students.

The concept of Education as a Service (EaaS) offers such a solution based on modern information technologies, creating a new partnership environment between all organizations and individuals involved in the process of creating and consuming education and training services.

The article describes one of the approaches to the implementation of the EaaS concept developed within the framework of the eMEDIATOR project. The purpose of the article is to describe the proposed model of the EaaS ecosystem, the main components of its architecture, as well as a demonstration portal that implements the main functionality of the EaaS concept.

The paper provides an overview of the platform sub models and DEMO Portal as the main project results (PRs):

- PR1. Architecture and concept of the portal.
- PR2. Model of the Pedagogical components of the portal.
- PR3. Model of the Organizational components of the portal.
- PR4. Model of the Competency components of the portal.
- PR5. Model of the Technological components of the portal.
- PR6. Description of the portal demo version that implements the EaaS model.

The described in the paper eMEDIATOR project hinges on the concept of virtual collaboration in the sphere of educational mobility. It brings value at the EU level by proposing an ecosystem of European educational mobility services that cannot be realized through activities limited to a single country. The result of research utilizes the principles of service-oriented, competence-based and student-centred approach with new opportunities for partnership between industry and academia to provide education and training for variety of employment opportunities within the European unified market for education and employment.

The article discusses the main advantages and limitations of the developed EaaS ecosystem model, as well as the main directions for future research related to the integration of promising information technologies into the model, in particular, blockchain and artificial intelligence.

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ORGANIZATIONAL MODEL FOR THE MOBILITY EDUCATION AS A SERVICE ECOSYSTEM: A MULTIDIMENSIONAL APPROACH

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Keywords: education ecosystem, digital platform, Education as a Service, organizational model, competence-based education

The digital transformation of society affects all its areas, including education. This urgently requires a change in the established paradigms of education based on new forms and methods of teaching and learning. One such innovative paradigm is Education as a Service (EaaS).

EaaS prioritizes competency-based learning, service-oriented education, open resources, student-centred learning, and academia-business partnerships.

The purpose of the article is to describe the organizational model for the EaaS ecosystem developed within the framework of the project eMEDIATOR.

The organizational model of the EaaS ecosystem is one of its main components. The model describes the interaction of all stakeholders in the implementation of the EaaS concept.

At the heart of the organizational model of the EaaS ecosystem is a digital collaboration platform designed to bridge information gaps between different stakeholders and ensure transparent, sustainable, continuous, and efficient service delivery.

The article describes the architecture of the organizational model, the services it provides, analyses the criteria for the effectiveness of its functioning.

The article describes the changes in the traditional structures of education when using the EaaS paradigm and the practical implementation of its organizational model. EaaS places the learner at the centre of a changing educational environment by connecting academia and business, promoting competency-based learning, and using digital technology to facilitate the delivery of educational services.

New opportunities in the implementation of the functionality of the EaaS organizational model are opened using artificial intelligence. The article describes various aspects of the use of artificial intelligence in the considered model, as well as new challenges that the use of artificial intelligence brings in the EaaS ecosystem. The paper proposes a roadmap of organizational model implementation and describes how educational services are managed, delivered, and evaluated, supporting competency-based and service-oriented learning in a student-centric manner. This roadmap provides a systematic approach to managing, delivering, and evaluating educational services in an EaaS ecosystem.

The paper contributes to the discourse on EaaS, offering an innovative organizational model that aims to ensure the robustness, effectiveness, and quality of Mobility EaaS ecosystems industry.

Acknowledgments

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ENHANCING COMPETENCE-BASED JOB SKILLS THROUGH MOODLE: A PARADIGM SHIFT IN MOOC APPLICATIONS

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Keywords: competences, model, moodle, skills, courses

In the rapidly evolving job market, acquiring relevant job skills has become increasingly crucial for students and employees alike. Massive Open Online Courses (MOOCs) have emerged as an effective platform for providing academic materials and fostering skill development. However, it is essential to combine these MOOCs with a competency-based approach to ensure the acquisition of job-ready skills. In this paper, we propose a competence-based job skill model that aims to integrate competencies into MOOC applications, specifically leveraging Moodle as a learning management system. This model serves as a guiding framework for students and employees to align their course selection with the desired job skills and competencies.

The importance of combining MOOCs with competencies cannot be overstated. Extensive research has been conducted in this field, highlighting the significance of integrating competencies into both courses and job skills (EU, 2006). Our work focuses on bridging this gap by facilitating skill development through MOOCs while emphasizing the importance of competencies. By aligning courses, competencies, and job skills, we aim to empower individuals in their pursuit of professional growth and success.

Related literature and existing work have explored the incorporation of competencies within courses and job skill development (Keenqwe and Gikandi, 2023) (Mulder, 2017). Previous studies have investigated competencies that can be combined with specific courses (Cedfop, 2018), as well as the utilization of Natural Language Processing (NLP) tools to enhance job skill acquisition. Building upon these foundations, our research seeks to establish a clear path: starting from a course, progressing to the acquisition of relevant competencies, and ultimately developing job skills. This structured approach provides students and employees with a comprehensive understanding of the necessary steps required to upgrade their skill sets effectively.

Many individuals often find themselves in a situation where they desire to enhance their job skills but lack the knowledge of which training courses or program curricula to pursue. Students, in particular, seek to build their personal portfolio of job skills, requiring them to select courses that align with their desired competencies and job skills. Similarly, employees are constantly seeking avenues to improve their skills in their respective jobs. In such scenarios, MOOCs can serve as valuable resources, guiding individuals towards the acquisition of relevant competencies and job skills. Our proposed competence-based job skill model provides a structured approach that aids students and employees in making informed decisions about their skill development journeys.

To implement this model effectively, we have designed a course that aligns with the competence-based framework. This paradigmatic course serves as a practical demonstration of how competencies can be seamlessly integrated into MOOCs. Additionally, we have developed a way to combine this model with Moodle in order to assist instructors in defining courses based on the requirements outlined in our model. This platform supports instructors in navigating the complexities associated with following the competence-based approach, ensuring that the course description and didactic material fulfill the necessary criteria.

In conclusion, our paper presents a competence-based job skill model that advocates for the integration of competencies within MOOCs, leveraging Moodle as a supportive platform. By establishing a clear path from courses to competencies and job skills, we aim to address the common challenge faced by individuals seeking to enhance their skill sets. Our work contributes to the development of a structured approach that facilitates skill acquisition and empowers students and employees to make informed decisions regarding their professional growth and success.

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DEVELOPING A SAFER EDUCATIONAL ENVIRONMENT THAT PRESERVES USERS' PRIVACY

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Keywords: RFID, P-ABCs, security, privacy, education

The integration of advanced technology in educational environments is of paramount importance for enhancing safety and privacy of students. There are many security solutions that provide a sustainable educational environment; however, they are not concerned with who collects the critical data of students. These critical data may include family status, degrees, images, presence, and medical condition. In this work, we propose privacy-preserving technologies to build a trustworthy educational environment and we try to identify the security and privacy considerations that may arise.

The basic idea is the usage of Radio Frequency Identification (RFID), a technology that enables to locate, real-time track, and identify objects or individuals using radio waves (Roberts, 2006), for developing a security system for students. The RFID consists of two components, the RFID tag and the RFID reader (Hawrylak & Hale, 2015). Every student must be equipped with a smart card that will serve as an RFID tag, containing a unique identifier. On the other hand, the RFID reader will act as the gateway between the student and the information system of the school. The RFID reader will collect student information every time they enter or leave the school, counting how many students entered and sending information to the professor in case someone is absent. The students' smartcard will not work for a third time a day so he/she cannot leave the school without permission.

Although many RFID-based attendance systems have been proposed in educational institutions, like (Meghdadi *et al.*, 2016), (Bharathwaj *et al.*, 2017), (Rahman *et al.*, 2019), they focus on children's safety, but they do not mention the security and privacy of their information data. There are several security and privacy vulnerabilities in RFID systems including tag cloning, eavesdropping/sniffing and replay attacks (Burmester & De Medeiros, 2011.; Grover & Berghel, 2011). During the last decade, several RFID authentication protocols have been proposed, especially in the health domain. The majority of these protocols, such as (Chou, 2014), (Jin *et al.*, 2016), (Shen *et al.*, 2017) utilise the Elliptic Curve Cryptosystem (ECC) to overcome the security flaws, however, subsequent research proved that there are still threats, like impersonation attacks, tag cloning and location tracking attacks (Shariq *et al.*, 2021), (Lamrani Alaoui *et al.*, 2021). Apparently, the use of wireless broadcast channels for data transmission could lead to privacy leakage. To ensure the security of the communication channels, protocols such as (Fan *et al.*, 2020) utilise cloud-based techniques claiming to be robust against the de-synchronization, tag tracking, and replay attacks. However, the authors in (Adeli *et al.*, 2021) showed that this scheme cannot withstand the above threats. To summarise, researchers have suggested several solutions,

including encryption, authentication methods, pseudonymization, and anti-sniffing techniques, to reduce security and privacy concerns.

To our knowledge, there isn't an RFID-based attendance system for educational environments that fulfills the security and privacy aspects. In this work, we try to implement the BCs (Privacy Attribute based Credentials) in the proposed RFID system, enabling students to authenticate themselves in a privacy-preserving manner. Additionally, we propose identity management applications via OLYMPUS cryptographic library (Bernabe et al., 2022; Moreno *et al.*, 2020), which enables users to keep control of their data, deciding who has access to it and how it might be used, providing improved protection. Also, we don't recommend the use of biometric data of students since they are stored in a database or the use of cameras that may raise concerns of privacy violation. As an improvement of our scheme, we will examine the implementation of GPS technology to improve students' safety, keeping in mind that the students must carry a GPS receiver or cellular phone.

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COMPETENCE MODEL PROPOSAL FOR MOBILITY IN EDUCATION AS A SERVICE

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Keywords: competences model, harmonisation, knowledge, skills, e-Learning

The foundation of education is the development of competences, which enable students to acquire formal and structured education as well as the skills and knowledge needed for a particular career. The term competence is broadly defined and encompasses a range of attributes and talents, including intellectual rigour, teamwork, effective communication and critical thinking. Organising teaching around competences leads to structured learning, which is essential for the complexity of higher education to be articulated. Competence models support students' learning pathways. They are therefore tools that students can use to check whether they are achieving learning outcomes. In the context of the European project “Ecosystem for European Education Mobility as a Service: Model with Portal Demo (eMEDIATOR)”, which is an ERASMUS+ project number 2021-1- LV01-KA220-HED-000027571, a competence model is proposed which is based on the Skills Framework for the Information Age (SFIA) and the Technological Pedagogical Content Knowledge (TPACK) model, together with the harmonisation of the competence standards IEEE 1484.20.1 & CWA 16655-1. The harmonisation of the standards was performed by means of the HFramework method. This method made it possible to analyse both the standards and the choice of attributes for defining competences. The competence model proposed was validated in a workshop of the eMediator project. In this workshop the model was briefly described with examples and the participants evaluated the model by filling in a survey. Overall, the perception of the model was positive and it was considered useful. Furthermore, the results of the survey highlighted the willingness of the participants to use it in a test scenario.

ARTIFICIAL INTELLIGENCE IN THE IMPLEMENTATION OF DIDACTIC PRINCIPLES IN A NOVEL MOBILITY PLATFORM: THE CASE OF THE EMEDIATOR PROJECT

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Keywords: artificial intelligence, didactic principles, eMediator project

Artificial Intelligence (AI) can support educational platforms in many ways: personalizing a learning process, supporting assessment and content organization, and assisting students. Its implementation in dedicated environments, such as the educational mobility platform, can help designers to create a versatile environment that meets the requirements of learners and teachers. The article aims to identify how Artificial Intelligence can aid the educational processes ruled by eight didactic principles. The principles govern the instructional design process and optimize the learning process. The study involves use cases for each didactic principle and their qualitative analysis to find how the AI could aid the achievement of the didactic principles. The results indicate that AI can facilitate the realization of didactic principles in educational endeavours in three key aspects: personalized learning content, individual assessment, and providing meaningful interactions. Moreover, algorithms can verify their realization in a faster and more accurate manner in comparison to human-driven educational processes.

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