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ABSTRACTS

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Plenary Session
PARADIGM CHANGES IN MOBILITY: WHAT DO WE KNOW AND HOW IS THE FUTURE LOOKING LIKE?

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Keywords: mobility, passenger traffic, urban freight, foresight, disruptive technologies

In the recent years, within the general trend of rapid innovation and digitalization, the mobility landscape has changed considerably, with the so-called “three revolutions”: shared, electric and automated (Sperling, 2018), leading to the emergence of new mobility solutions. New modes appear (and disappear) at a blink of an eye, without any prior information or notification, and -typically- without any regulation or coordination (at least initially). We are called to forecast the impact of highly automated vehicles, when the technology is not yet here, and the trajectories for transition from a fully conventional vehicle fleet to a partly or fully automated one is expected to take decades. These uncertainties are not only related to the technological characteristics and the capacity of the vehicles, but also on the business models that will become wide-spread (e.g. individually owned vs. shared).

The situation is exacerbated when dealing with more volatile new modes. For example, Uber (a rather new phenomenon, founded 10 years ago), is currently generating 14 million trips daily, while its Chinese counterpart DiDi is generating 30 million trips daily. Uber has extended its business model from single passenger trips to shared trips, while recently decided to also offer shared bicycles, scooters, and even helicopter rides (operation started in New York City in May 2019). Respectively, modes and services are also removed from the offered mobility mix in the cities, often as fast as they appear, e.g. the obike shared bike system that flooded European cities (such as Munich and Zurich) in 2017, only to disappear in 2018, amid privacy and sidewalk-squatting complaints. Similarly, a recently inaugurated shared electric bicycle systems in the northeastern US were shuttered, a few months after the start of operation, due to safety concerns.

What complicates the situation even further is that, besides the nature of the modes, their funding, business model and ownership status varies, as well, as these initiatives are typically not controlled by the authorities, but originate from private companies (ranging from start-ups to established entities like car- and aircraft manufacturers). The uncertainty is also great, as many business models are tried at the same time; e.g. Airbus is developing a large number of different urban air mobility vehicles in parallel, in order to cover all possible outcomes, while Uber (and similar companies like Lyft and Grab) also explore different types of services.

Disruptions are also taking place in freight transport and especially last-mile deliveries in a similar, if not larger magnitude. Starship Technologies started operating autonomous ground drones last year in several cities, and has already served 100.000 customers covering almost half a million kilometers. Amazon and others are testing air drones, while they have also started implementing crowd-shipping options (such as Amazon flex), where anybody can sign up to deliver packages for the last mile, instead of company employees. Interesting initiatives, like the City2Share project, offer other novel ideas, such as replacing delivery vans through the

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1 https://www.businessofapps.com/data/uber-statistics/
3 https://flex.amazon.com
4 http://www.city2share.de
establishment of micro-hubs, which are implemented by placing containers in suitable locations. This obviates the need for delivery vans to crisscross the city for the final package delivery. The containers serve as micro-hubs, from which last-mile deliveries take place with cargo-bikes. Another major disruption, which actually fades the division between passenger and goods services are the food delivery services, such as Delivery Hero (incl. foodora, having raised more than $1.5 billion), Deliveroo, and uberEATS.

In this research, we explore this issue and provide some insight into how we could best cope with the degree of uncertainty that future developments entail.

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References
VEHICLE ABSOLUTE EGO-LOCALIZATION FROM VISION, USING ONLY PRE-EXISTING GEO-TAGGED PANORAMAS

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Keywords: Intelligent Vehicle, ego-localization, visual localization, deep-learning, place visual recognition

Precise ego-localization is an important issue for intelligent vehicles. Geo-positioning with standard GPS often has localization error up to 10m, and is even sometimes unavailable due to "urban canyon" effect (Drawil et al., 2012). Odometry, whether based on wheels or on vision or lidar, is unreliable on long distance, as it is bound to drift due to error accumulation along trip (Zhang & Singh S., 2015). As for precise-enough inertial reference system, they are generally too expensive for vehicles. \textit{It is therefore an interesting goal to design an affordable and robust alternative to GPS ego-localization}. In this paper, we propose an approach for absolute ego-localization based on vision only, and not requiring previous driving on same street: we show that it is possible to obtain GPS-level precision (few meters) of localization by leveraging only pre-existing geo-tagged panoramas such as those from Google StreetView (Anguelov, 2010).

Our method firstly generates, from each geo-tagged panorama, several synthetic rectilinear images with the same characteristics (focal length and field of view) as the target on-board camera, but many varying yaw angles within a plane parallel to the road. Secondly, since there is typically 10-15 meters between two successive geo-tagged StreetView panoramas, we augment the obtained dataset by synthetizing also extra images that could be seen from several translated positions between panoramas. This is made possible by the availability for each StreetView node of a depth panorama, quite crude (essentially the main flat surfaces such as facades of building) but sufficient to allows to compute those offsetted views with simple geometric back-projection formulas (details in Yu et al., 2016b).

From this dataset, we have tested and compared two very different approaches for estimating localization from on-board query image:

- compute visual keypoints in query image, and match them with keypoints pre-computed on the whole dataset of geo-tagged images, followed by a 6 DoF relative camera pose (i.e. position and orientation) estimation using bundle adjustment (details in Yu et al. 2016a);
- direct pose regression computed by a deep Convolutional Neural Network (CNN) taking the query image as input; the CNN is pre-trained beforehand to map all synthetic images in dataset to their actual camera position and orientation, with an approach similar to that of PoseNet (Kendall et al., 2015).

We have evaluated our 2 proposed variants using a real car, equipped with a monocular camera and a differential RTK GPS providing centimetric precision for position ground truth. We have driven around 1 km in a dense urban area. The obtained average localization error was:

- 2.8m with visual keypoints-matching + geometric computations;
- 7.7m with pose regression using pre-trained deep CNN.

It is therefore indeed possible to obtain \textit{from vision alone} an absolute ego-localization with a precision similar to that of standard GPS. The ego-localization error was significantly larger with CNN pose regression. However, this is probably partly due sub-optimality of the
training of our CNN regressor, due to lack of time; with optimized hyper-parameters of learning, CNN-based localization accuracy would probably significantly increase. Furthermore, the on-board computation time for one query image is approximately 75 ms with CNN instead of 40 times more (~3s) for keypoints+geometry. This makes the CNN-based approach much more applicable in practice.

The proposed approach is therefore a potentially interesting complement to GPS localization. We further analyse and discuss its practical applicability, in particular its scalability to city-wide or country-wide localization system.

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References

Data Science in Transportation
COMBINING LSTM ARTIFICIAL RECURRENT NEURAL NETWORKS AND FRACTAL ANALYSIS FOR INVENTORY DYNAMICS PREDICTION

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Keywords: inventory dynamics prediction, inventory management, LSTM, fractal analysis

Modern markets are extremely competitive. Businesses are facing unceasingly growing pressure on both prices and quality. According to IHL Group's report, a tremendous share of capital, namely $1.1 trillion in cash or equivalent to 7% of the U.S. GDP are tied up in inventory (IHL and Buzek, 2015). Besides that, the company is required to swiftly respond to stochastic market conditions. The daily pressure of inventory management can feel like a neverending struggle. Incorrect inventory policy can lead to both corporate losses and overproduction. Besides financial issues, the last one incurs collateral damage to environment.

Inventory dynamics is the difference between inbound and outbound flows, which is a subject of various factors, such as seasonality, degree of competition, technological failures, labour-related issues, supply-chain-related factors, inflation, change in government laws and so on. Alternatively, inventory dynamics can be efficiently treated and studied as time series (Gardner, 1990; Spedding and Chan, 2000). Originally developed for language models by Hochreiter and Schmidhuber (1997), long short-term memory (LSTM) artificial recurrent neural networks have also demonstrated state-of-the-art performance on the tasks of time series prediction (Chen et al., 2015).

Qian and Rasheed (2004) demonstrated for financial data that time series with large Hurst exponent (Hurst, 1951) can be predicted more accurately using artificial neural network. Due to seasonality of demand and periodicity of replenishments, inventory dynamics can be highly self-similar. This paper demonstrates that such metrics of fractal analysis as Hurst exponent, correlation dimension and sample entropy indicate predictability of inventory dynamics by LSTM networks. From business point of view this finding is useful, because one can identify time series with large self-similarity metrics before attempting to build a model for prediction. Furthermore, it is possible to focus on the periods with large metrics, which will save time and computational budget.

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1. IHL-group and Buzek G. (2015) Research Study: We Lost Australia! Retail's $1.1 Trillion Inventory Distortion Problem.
MAKING WAREHOUSE LOGISTICS SMART BY EFFECTIVE PLACEMENT STRATEGY BASED ON GENETIC ALGORITHMS

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Keywords: 3PL, Logistics, Genetic Algorithm, Optimization, Labor costs

Supply chain executives are faced with the challenge of reducing labor costs. Travel time or picking efficiency can easily account for 50% or more of order picking time. If we omit human factor and the technical equipment of the warehouses, picking efficiency is mostly affected by two factors: correct combining orders into a single travel instance and picking orders in batch is the first factor; the second one is a goods placement – the more effective the goods are located, the shorter will be the picking distance for each order or batch of orders. It means that individual orders will be picked faster. Usually to determine the correct location for the goods 3PL’s are using ABC analysis that includes indicators like count of orders, goods turnover, picking rate, weight etc.

There are also more complicated indicators like goods adjacency. Such indicators are harder to take into account using ABC analysis, as it requires sophisticated analysis of customer orders.

In recent publication (Avdeikins et al., 2018) goods placing by results of ABC analysis was compared to the genetic algorithm approach. It was showed that genetic algorithm much more effective for goods placing.

The goal of this paper is to improve developed genetic algorithm and include in calculations factors of the labor costs and warehouse topology. These factors will make algorithm usable in real warehouses and WMS (warehouse management system) information systems.

References
ECONOMIC EFFICIENCY OF DATA-DRIVEN FAULT DIAGNOSIS AND PROGNOSIS TECHNIQUES IN MAINTENANCE AND REPAIR ORGANISATIONS

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Keywords: predictive maintenance, airplane health management, economic analysis, gaps, macro and micro analysis

Maintenance costs represent a significant part of economic expenses for the aviation industry. The development of data-driven fault diagnosis, prognosis, and health management techniques create unique opportunities to increase the efficiency of maintenance and repair organization (MRO) activity and, as a result, reduce airline maintenance costs. Nevertheless, despite the widespread of data-driven prognosis ideas, the economic success of maintenance and repair organization in data-driven prognosis remains rather frugal and local.

The central part of the challenges which influence MRO economics are related to prediction and planning activity. Levitt (2003) notes that from an economics point of view, the main goal of technical maintenance is to get out of the maintenance business. As this is ideal and not achievable goal MROs have to deal with the prediction activity and have to decide in which part this makes a sense for them. Despite the importance of the economic side of predictive maintenance, the majority of researches in fault prognosis area are more about engineering and mathematic and only a tiny portion touches on economic incentives. A lot of MRO still do not know how to approach with predictive maintenance due to the lack of a consistent theory and strategy for the development of data-driven projects, the lack of a standard has proven mechanisms and methodology that allows MRO to make decisions regarding the development of predictive projects, and evaluate their economic performance. The review of the current research in this area shows that more attention needs to be paid to the following issues: 1) systematic description and complete understanding of failure forecasting embedding into the overall development strategy and interacting with other elements of the strategy; 2) venture character of data-driven prognosis projects, the company attitude to the risk and the methodology on how to identify which aircraft systems should have higher priority for forecasting; 3) specifics of the production practices and operational processes of MRO as well as the practical aspects of the maintenance; 4) use cost criteria of efficiency rather than quantitative criteria.

This paper reviewed the existing literature related to the economic efficiency of data-driven projects, defined the gaps in economic analysis and proposed the methodology how to support MRO to deal with the predictive maintenance projects effectively on macro, semi-macro and micro levels.

References
METHODOLOGY FOR CALCULATING ETL INDICATORS IN THE PROCESS OF IMPLEMENTATION OF AIRCRAFT MAINTENANCE INFORMATION SYSTEMS

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Keywords: data source standardization, extraction transformation loading, framework, migration metrics, maintenance information system

In the area of aircraft maintenance and operation, since the industry imposes significant requirements on data integrity and consistency, the task of building reliable and technically modern maintenance information systems is very important [1]. One of the most difficult stages of any system implementation is data transfer. The number of resources expended and the success of the project in general largely depend on the chosen approach to the implementation of this task.

The widespread use of automation of data transfer processes is expected to reduce the time for data transfer and qualitatively improve the result of data extraction, transformation and loading, as well as increase the manageability of the process, due to the implementation of the capabilities of the analytical assessment of the success of various stages of the project.

The data transfer is always an iterative process in which scope and requirements for migrated data increase from iteration to iteration. The transition from one iteration to another and the Go Live of the system, in general, is possible only if the calculated indicators of migration correspond to predetermined threshold values and all identified errors are described in detail and evaluated in terms of acceptable project risks. Also, the indicators are static, their dynamics are important for an understanding of the implementation process.

The selection of the optimal metrics and choosing the right data assessment technique is a very complex task, which in itself is the subject of scientific research [2]. On the one hand, the metrics must be accurate enough to correctly reflect the status of the implementation process, and on the other hand, simple enough to be easy to calculate. More than that we can use different indicators for different purposes, but in general they could be either quantitative or qualitative.

The development of the universal method for assessing the effectiveness of extraction, transformation and loading processes (ETL) is the main task of the study. This was accomplished by constructing a method to represent heterogeneous source and target data in the form of single arrays, a method for describing the interactions and influences between data, and a method for assessing qualitative and quantitative indicators of migration, including considering the influence of the expert knowledge on assessing the results of the migration iterations. The analytical calculations obtained as a result of applying the method in practice will allow a more objective assessment of the risks and the need to attract additional resources at all stages of the project.

References


AIRCRAFT LIFECYCLE DIGITAL TWIN FOR DEFECTS PREDICTION ACCURACY IMPROVEMENT

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Keywords: Aircraft Maintenance, Aircraft life cycle, Digital twin, Defects prediction, Data ontology

Prediction of defects is essential for Maintenance and Repair organization in order to plan workload, tools and hangar capacity and materials. Standard experiences based approach that uses man-hours rate to scheduled works with taking into account aircraft age jointly with prediction of spare parts requirements on the basis of historical consumption does not provide sufficient accuracy as each airplane has a unique operational life cycle and condition. It brings to over or under capacity and overstock. This paper describes the limitations of current approaches and propose an approach to the modelling of aircraft operational life cycle as a digital twin of system Aircraft plus operational and maintenance environments. Ontology of operational life cycle data presented. Applying machine learning methods to this digital twin accompanied by analysing of each task individually will allow to increase prediction and planning precision.
INTELLECTUAL ENVIRONMENT AS A DECISION SUPPORT SYSTEM FOR INVENTORY MANAGEMENT FOR AVIATION MAINTENANCE AND REPAIR OPERATIONS

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**Keywords:** predictive maintenance, ecosystem of aircraft operation, forecast, machine learning

Nowadays, maintenance costs of commercial airplane make a remarkable contribution to airline’s operational costs breakdown. Moreover, each day when the aircraft is out of operation for maintenance airline still pays for aircraft ownership or leasing. Additionally, it’s a loss of potential profit for the airline. Thus, one of the ways to reduce airline costs for maintenance is to reduce aircraft down time for scheduled maintenance events or turnaround time.

One of the decisions could be analysing each task individually and developing of defect prediction models that consider not only age of aircraft but also areas of its operation, defects between heavy checks, and other factors that directly or indirectly could show us significant similarity between considered situation and others where hidden defect was found. Thus, a system, which will be able to predict probability of hidden defects, can have a significant positive impact in rationalisation of aircraft maintenance process.

Development of prognostic system for base maintenance has some difficulties. First of all, it is the large amount of data. For example, A320 family maintenance planning document (MPD) contains of more than three thousand tasks multiplied by hundreds possible aircraft configurations. For tracking of the tasks maintenance and repair organisation (MRO) uses maintenance informational systems such as AMOS, TRAX or SAP based applications. These systems keep information about the tasks and MRO’s experience of tasks execution, history of findings with reference to MPD task and spares that were used for defect rectification. All this data is very important for defects prediction. However, this amount of information is difficult to analyse manually.

Nowadays there are automatic analytic systems in area of predicting fault and warning for such a system of aircraft like engines and chassis. But there is no highly spread system for producing fault and warning for fuselage parts or consumable items. Prediction of demand for certain items generally lays on experts, including predicting of hidden defects and their demands.

General purpose of this paper is description an approach of machine learning use for predicting hidden defects on aircraft which, in the first place, connected with parts not covered with existed analytic systems, for example, fuselage parts and consumable. In the paper the approach for development of an instrumental platform based on the intellectual environment using forecast models of artificial intelligence as a tool for decision support systems for inventory management for the maintenance and repair of aircraft is discussed.
DEFINING THE PROPER MODEL FOR AVIATION SPARE PARTS FORECAST

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**Keywords:** Demand Uncertainty, Aftermarket, Planning Horizon, Boosting, ARIMA, Exponential Smoothing, Consumption, Planning Accuracy

Nowadays airline margin and the margin of the maintenance providers for aircraft depend strongly on the possibility to reduce the time AC is on the ground due to maintenance reason. Industry statistics show that the ground time because of aircraft repair is influenced by the lack of a spare part needed to be installed. Research in this area shows that in Russia 70-75\% of time aircraft spend on the ground due to this reason.

A focus-group survey of companies based in USA showed that according to almost 30\% of Maintenance Repair Organisation representatives consider the key area to tackle is improving the accuracy of spare parts consumption forecast and optimizing supply chain management. This means that in order to increase the availability of aircraft the factor of spare parts delivery is of vital importance to reduce the airplane ground time and improve dispatch reliability. 1 day for 1 aircraft on the ground costs an airline about $50k.

Today in civil aviation there is no standard model or instrument to plan material requirements. Many companies use “so called” min/max planning. In reality, the accuracy of this model turns out to be insufficient and this leads either to spare parts deficit or to overstock at the warehouse. Recommendations done by the manufactures in this area are not effective and lead to excessive spare parts on stock. Money assessment of existing stock is 2 times higher than the aftermarket requirement.

This work aims to define where the problem in the accurate forecast is, what models exist and what are the best models that suit spare parts consumption prediction. All the major contemporary approaches that exist nowadays are regarded in connection to the research area. As well this work tries to figure out if the forecast model works the same way for various spare parts categories and types and if it is possible to set an optimal planning horizon.

The result of this work is to define the model that will be more accurate compared to classical approach of forecast in condition of demand uncertainty and reveal if it could be done with standard data the company has in aviational industry. This action is supposed to increase significantly planning accuracy of Maintenance Repair Organisation or Airline company and help business to cut down costs and reduce turn around time for aircraft maintenance.
MAKE IT FLAT: MULTIDIMENSIONAL SCALING OF CITY-WIDE TRAFFIC DATA

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Keywords: spatiotemporal models, machine learning, image processing, urban traffic modelling

Urban traffic forecasting is an emerging problem in transportation engineering that attracts academic attention over past decades. Modern intelligent transportation systems collect urban traffic data as multidimensional (spatiotemporal) time series — thousands of sensors, deployed on a city-wide road network, provide time series of several traffic characteristics (volume, occupancy, speed). These data have an extremely high dimensionality and are hard to be modelled using classical statistical models.

Spatiotemporal contour (SC) diagrams (or time-space diagrams) that represent traffic speed or occupancy dynamic over space and time is an important tool in transport research and applications. SC diagrams are widely used for analysis of traffic conditions (He et al., 2015), identification of bottlenecks (Song et al., 2018), and traffic forecasting (Zhang et al., 2017). Recently Ma et al. (2017) suggested learning of traffic SC diagrams as images, which deals with high dimensionality of data and allows application of modern machine learning techniques (e.g. convolutional neural networks).

One of the main limitations of SC diagrams is their 2D structure (one dimension for time and one for space). Thus, SC diagrams are appropriate for linear space structures only — for example, for express ways or arterial roads. However, the typical spatial structure of city-wide traffic flows is not linear: road segments are located in the two-dimensional space with non-metric distances. In non-metric space “distances” (e.g. travel times) from point A to point B and from point B to point A are not equal (non-symmetry); “distance” from A to C can exceed sum od distances from A to B and from B to C (violation of the triangle inequality). Thus, construction of city-wide traffic SC diagram is a challenging problem, and its practical utility is not obvious.

In this study we propose an approach for construction of city-wide SC diagram using the multidimensional scaling (MDS) technique. The proposed approach includes definition of metric distances between spatially distributed time series (using the time series coherence metric) and further application of MDS for projecting obtained distances to the one-dimensional space. Resulting one-dimensional space projections are merged with times for constructing SC-like diagrams.

The proposed approach was applied to a large real-world urban traffic data set and obtained SC diagrams were utilised for solving traffic forecasting problem. Experimental results demonstrate good statistical properties of the proposed approach.

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References

NEUROEVOLUTIONARY APPROACH TO METAMODELLING OF PRODUCTION-INVENTORY SYSTEMS WITH LOST-SALES AND MARKOVIAN DEMAND

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Keywords: Metamodelling, Inventory control, Production planning, Neuroevolution, Neural architecture search, Automated machine learning

Industrial systems aim to producing high-quality products in the most economical and timely manner. Today such systems are evolving and becoming more complex, flexible, and information-intensive (Altiok, 2012). Moreover, production-inventory problems are extremely varied in terms of technology, structure and practices. Unfortunately, they are frequently subject to oversimplification. For instance, two crucial assumptions in the vast classical production-inventory models have been made. Firstly, demands are considered independent of environmental factors and identically distributed. Secondly, unsatisfied demand can be backordered and fulfilled later. However, in practical settings a production-inventory model must be able to deal with lost-sales and incorporate Markovian demand. However, as it mentioned by Duan and Liao (2013), such extensions along with dimensionality and complexity of real-world problems make model analytically untraceable. That is why, simulation-based optimization remains the most popular tool for solving complicated business-driven problems of such kind (Jalali and Nieuwenhuyse, 2015). Unfortunately, simulations, especially detailed are greedy for computing resources. In the light of these facts, it may be more reasonable to use an alternative cheaper-to-compute meta-model, which is specifically designed in order to approximate an original simulation with a sufficient degree of accuracy (Merkuryeva, 2004).

Over the last decade artificial neural networks (ANNs) have demonstrated remarkable performance on a variety of tasks including fitness approximation. Moreover, with recent revolution in deep-learning, metamodelling of industrial systems based on ANN has sparked the surge of interest in simulation community. Nevertheless, ANNs are usually developed manually by data scientists and artificial intelligence developers, which is quite fault prone and requires the sheer amount of time. Considering this fact, an interest in automated neural architecture search methods is growing drastically in various domains including metamodelling (Elsken et al., 2019). This paper discusses the application of neuroevolutionary automated machine learning to metamodelling of complex production-inventory systems. The proposed framework incorporates multilayer perceptron and genetic algorithm.

References
MARKOV-MODULATED PROCESSES, THEIR APPLICATIONS AND BIG DATA CASES: STATE OF THE ART

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Keywords: Markov-modulated process, random environment, Markov additive process, big data

Markov-modulated processes are processes that are modulated (or driven) by an underlying Markov process. The study begins with a review of the earliest models found in the literature, as Markov-additive processes, which in turn are generalizations of Lévy processes. Markov-additive process \((Y,J) = \{(Y(t), J(t)), t \geq 0\}\) is a two component Markov process defined on the state space \(R \times N\), so that for \(s, t \geq 0\) conditional increment \((Y(s + t) - Y(s), J(s + t))\) under the condition \((Y(s), J(s))\) depends only on \(J(s)\). Component \(J(s)\) is called Markov, and component \(Y\) is additive. Depending on the type of model by means of which the component \(Y(s)\) is described, processes such as Poisson, Bernoulli, Hawkes, regression and other are considered. In many applications component \(J(s)\) represents some non-observable extraneous factors, that’s why some authors call Hidden Markov Models. The study includes an attempt to systematize various Markov-modulated models, draw a boundary between different types, or vice versa to combine different models with the Markov component into one.

Various areas of application of this type of model are described, such as traffic, queuing theory, risk theory, management, health, communications etc. Examples are considered that illustrate the use of Markov-modulated models in the case of big data.

The research strategy includes a search for literature in the most popular and influential databases, such as ScienceDirect, Web of Science and Springerlink.

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References

ANALYSIS OF A FLOW OF COMPLEX MESSAGES FORMED BY TWO POISSON FLOWS OF ELEMENTARY MESSAGES

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Keywords: Erlang distribution, Markov chain, Correlation analysis

Random flows play a big role in the applied probabilistic models: reliability, queueing, inventory, risk, transportation, which are only part of the application area examples. A transmission of signals and information gives new models of message’s flows. They describe a union of elementary messages into a complex message and, on the contrary, divide a complex message in many elementary messages.

The following problem is considered in this paper. Two independent Poisson flows of elementary messages arrive at a commutation node. The intensities of the flows are \( \lambda_0 \) and \( \lambda_1 \), correspondently. Waiting places are restricted and equal \( w_0 \) and \( w_1 \) for the zero and the first types of the elementary messages. Further \( m_0 \) elementary messages of the zero type and \( m_1 \) elementary messages of the first type (union) are combined into one complex message. We wish to investigate an output flow of the complex messages in the stationary regime.

The following indices of the output flow for the stationary regime are considered: the distribution of numbers of elementary messages at time instant, when the complex message is formed; distribution of intervals between complex messages; a covariance and a correlation coefficient of two adjacent intervals. Numerical example illustrates obtained results.
TWO-LEVEL RECURSIVE IDENTIFICATION OF HAMMERSTEIN SYSTEM BY INTERACTION PREDICTION METHOD

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Keywords: System Identification, Hammerstein System, Non-parametric estimation, Decomposition and Coordination

The paper concerns identification of Hammerstein system under nonparametric prior knowledge about the static nonlinear characteristic. The identification task is decomposed by the prediction of the hidden interaction signal. The standard kernel approach is modified to cope with the problem of constant offset between the regression function and the static characteristic in Hammerstein system, which was not solved in the previous papers. The idea is based on alternate updating of the offset and the estimate of the impulse response of the linear block. Both levels of the algorithm are given in the recursive version.
USING CLUSTERING ALGORITHMS TO IDENTIFY RECREATIONAL TRIPS WITHIN A BIKE-SHARING SYSTEM

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Keywords: Travel demand, Clustering, Bike-sharing system, Recreational trips

Urban planners and governments today are faced with the dilemma of providing high-quality mobility services to a growing population, while at the same time minimizing energy consumption, reducing harmful environmental impacts and cultivating a lively and safe urban environment. As a means of meeting these challenges, the bicycle has resurfaced as a valuable transportation mode (Twaddle et al., 2014).

In spite of recommendations for conducting cycling studies, one of the trends is the creation of bicycle traffic systems, which constitute an integral part of the transport system of urban areas without making traffic forecasts. Pedestrian and bicycle traffic have been neglected for decades when preparing travel demand forecasts. Urban planners have started looking for ways to set priorities, and one of them is to anticipate demand or rely on current data (Terner et al., 2006). Until recently, achieving accurate estimates of the demand for bicycle traffic was very difficult due to the lack of data, but currently a sharp increase in the availability of data on bicycle travel can be observed.

New comprehensive data sets as an addition to the classic methods include automated counters, crowdsource GPS tracks and data on the bicycles use (Proulx and Pozdnukhov, 2017). GPS path tracks as a promising technique for collecting data on bicycle traffic (Kuzmyak and Dill, 2012). Currently, one of the possibilities of acquiring a large amount of information on bicycle traffic is the analysis of data from urban bicycle rental systems (Nair et al., 2013).

This paper aims to present the approach to the GPS data cleansing, proposed by the authors in order to obtain the purified sample for studies of demand for trips in bike-sharing systems, and to demonstrate the use of the obtained big volumes of data in the clusterisation procedures for identification of recreational trips completed within the Wavelo bike-sharing system in Kraków, Poland.

References
Reliability in Transportation
FORMATION AND DISTRIBUTION FLOWS OF EXTERNAL TRANSPORT IN THE CITY

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Keywords: traffic flows, passenger flows, transport, infrastructure, modeling

Currently, there are two areas of passenger transport services: on the one hand it is the work of transport in line with the demand for its services and on the other hand the work of transport is formed by the demand for transportation, depending on the capacity of the transport system. Investigation of the transport services market formation is based on research of processes of settlement and spatial self-organization of population, determining the density of transport links, hubs of origin and suppression of passenger traffic flow. In modelling of passenger transport system we should use an approach that is based on a study of the interaction patterns of population and business with transport flows. The main point here is to establish a kind of feedback loop of objects located in the area on mobility in the transport service: planning network, its capacity (throughput and carrying capacity, speed, reliability and regularity of communication, comfort and safety of transportation), the study of settlement patterns and spatial self-organization of population.

The volume of traffic is measured by the number of planned or actual passengers. The background is the transport mobility of the population.

Determination on the basis of transport work for any period allows for projects planning to choose a rational relationship between settlement and transport infrastructure, to calculate the required number and type of rolling stock, to make the route network rational, and optimally distribute the rolling stock on the network.

Potential mobility that meets the requirements of population displacement is determined in accordance with the biological and social needs, socio-economic characteristics, production necessity, and cultural needs. Because of multifactor character and complexity of relationships it is impossible to determine the potential mobility by calculation method.

The feasibility of different target movements, depending on their distance, is regarded by rural populations differently. Each rural settlement is located among many other rural and urban settlements with an individual quantitative and qualitative set of social, cultural and industrial potential. With the developed road network and public transport system the population selects the centre of gravity with the limitations imposed by this transport system, and is based on subjective considerations about quality of service. The distribution of urban residents’ movements to the rural areas is affected by size of the city, moving distance, moving purpose, i.e. the same factors as rural residents’ moving to cities. The difference is that the radius of urban residents’ movement distribution is much smaller. Thus, zone of intensive and regular movements in the working day cycle covers only nearest to cities rural area with a radius of 15 km. On weekends due to guest visits and holiday trips the radius of this zone extends approximately 1.5-2 times.

On the basis of the links distribution the scatter band of the initial and final points of movement can be obtained. Since the density of scattering varies with respect to settlements, then on their sets we can allocate the territorial units that will make service zone.
Research results can be an integral part of comprehensive studies of determining the transport links density, hubs of passenger flows’ origin and suppression, in order to construct mathematical models of the most efficient passenger transport system operation.
STATIC APPROACH FOR SOLVING THE PROBLEM OF CARGO WEIGHT DISTRIBUTION ON VEHICLE’S AXLES

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Keywords: cargo vehicle loading, weight-in-motion, axles load distribution, cargo balance, road transport safety

The problem of balanced vehicle’s load and axle weight distribution is one of the important research topics in modern field of transport logistics and telematics. It is relevant not only to create intelligent planning systems for loading and managing a fleet of vehicles, but also to monitor compliance with vehicle loading regulations, protect the road surface from premature destruction and maintain the level of traffic safety. Incorrect location of the cargo inside the vehicle leads to a change in its dynamic characteristics and can cause serious accidents.

Sufficient number of methods and online calculators for determining the load on the axles is known where the distribution of the weight of the load depends on the number of axles, the axial distances and the position of the load along the longitudinal axis of the vehicle. However, the accuracy of such analysis tools seems to be unsatisfactory due to the approach to the simplest two-support beam model.

In present article it is proposed to search for the solution of this problem, considering the model of weight distribution in a multi-span continuous beam, based on hinges, which requires the use of methods for calculating statically indeterminate systems (Williams, 2013). It also proposes an approach to solving the problem for multi-span beam, based on static description of the problem transformation into the system of nonlinear equations (Grakovski and Pilipovecs, 2017) solved by numerical methods.

The results obtained by numerical methods are compared with the results of computer modeling of vehicle axle loading. It allows estimating the accuracy of the numerical methods used. The comparative analysis of various approaches to determining the loads on the vehicle axles is presented. Numerical examples of the distribution of the weight of the cargo along the axes in comparison with the classical approach and measurement results are given here.

References

APPLICATION OF DEFORMATION SENSORS FOR STRUCTURAL HEALTH MONITORING OF TRANSPORT VEHICLES

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Keywords: monitoring, vibration, modal, parameters, deformation, sensors

Needs in structural health monitoring (SHM) of transport vehicles grow up in energy and transport sectors caused by safety problems and economic reasons. Such tendency is especially evident in aviation where problems in SHM application appear. In contrast to operating machines and mechanisms, where effective diagnostic systems are already applied, the structural elements may be surveyed by non-destructive techniques only. Such techniques are applicable only for non-operating structures, so in order to survey condition of structural parts of an aircraft, wind generator or a pipeline, one needs to wait for the next technical maintenance stop. The structure’s technical state remains unobservable for a long time and operates at higher risk.

In recent years new techniques appeared that utilize modifications of modal parameters for monitoring of operating structures. Some of these techniques apply operational modal analysis (OMA) that allow modal parameters estimation of a structure operating under its natural conditions and being excited from ambient forces. The main provision of such techniques application is the sensors array reflecting vibrations of whole structure. OMA based techniques for structural monitoring demonstrate promising results in trials, however, sensor networking meets complications in practical application. For experimental SHM system playing the role of a technique demonstrator the accelerometers is typically used as sensors. However, in order to build a system for serial application on operating structures more economical solution to be considered, because of high cost of tenths or hundreds of accelerometers. Also its mass and sizes may affect modal parameters, when the object is a rotating blade, for example. Replacing accelerometers with deformation sensors with very low mass and thickness can be cost saving. This economically good solution requires theoretical basement of relation between dynamic deformations of vibrating structure and its vibrations, for which OMA techniques were developed.

Considering clear bending of the beam the paper discusses theoretical correspondence between displacement of beam neutral layer and deformation of its surface layer. Using some assumptions it is decided to relate dynamic deformations of surface layer to second derivative of neutral layer displacement of the bending beam. There is consideration of such approach practical application to the data obtained on experimental testing of composite rotating blade. Authors compare modal parameters computed from accelerations measured on the statically mounted blade and vibration deformations of this blade in both static and rotating states. Based on experimental data confirming theoretical consideration it is resumed about acceptability of OMA techniques application to deformations measurement for modal properties identification. Above approach makes comparison of modal properties based on deformation and vibration measurements. There are prepositions for deformations sensors application for sensor arrays in advanced SHM systems.
EFFICIENCY ANALYSIS OF A SMALL UNIVERSAL PLATFORM TYPE SWATH

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Keywords: SWATH, acceleration, platform, MSI

A Small Waterplane Area Twin Hull (SWATH) ships is one of the attractive variants for solving the problem of providing high seaworthiness at small sizes. At the same time, the question of estimating the size limits of such platform takes place, at which the SWATH will have an advantage not only in seaworthiness, but also in the efficiency of the tasks assigned to it (Zvaigzne and Bondarenko, 2017).

To carry out such an analysis, several variants of a SWATH platform were studied and their navigability and operational qualities were analyzed. The following indicators were used as the main indicators:

- vertical acceleration of gravity;
- indicator of comfort MSI;
- slamming probability;
- speed loss coefficient on the waves.

Let us study in more detailing the procedure for calculating these characteristics.

Vertical accelerations in the initial stages of the design of a universal platform can be determined by semi-empirical dependencies recommended by various classification societies. In particular, in accordance with (Guidelines, 2005):

\[
a_{cg} = \frac{K_T}{426} \left( \frac{V_H}{B_{WL}} \right)^{1.4} \left( \frac{H_{1/3}}{B_{WL}} + 0.07 \right) \left( 50 - \beta \right) \left( \frac{L_{WL}}{B_{WL}} - 2 \right) \frac{B_{WL}^3}{\Delta} g, \ m/s^2,
\]

where \( K_T \) – hull type factor, 0.8 for SWATH; \( L_{WL} \) – vessel length, m; \( B_{WL} \) – total pillar thickness, m; \( V_H \) – vessel speed at sea with the height of significant waves \( H_{1/3} \), knots; \( H_{1/3} \) – height of significant waves, m; \( \beta \) – bottom deadrise angle (10° ≤ \( \beta \) ≤ 30°).

Currently, the comfort estimating of the universal platform can be carried out using the Motion Sickness Incidence (MSI). There are two approaches in calculating MSI.

The first uses the empirical formulas proposed by O’Hanlon and McCauley (1974):

\[
MSI = 100 \Phi(Z_a) \Phi(Z_t), \%
\]

where \( \Phi(Z) \) – the integral function of the standardized normal distribution, is determined by the formula

\[
\Phi(Z) = \frac{1}{\sqrt{2\pi}} \int_{-\infty}^{Z} \exp \left[ -\frac{x^2}{2} \right] dx; \ Z_a = \frac{\log_{10} a_z - \mu_a(f) + 0.47}{0.5027}; \ Z_t = \frac{\log_{10} t - 1.46 + 0.57Z_a}{0.5027};
\]

where \( \mu_a = 0.87 + 4.36 \log_{10} f + 2.73(\log_{10} f)^2; \ t \) – the time of vertical motions effect, min; \( f \) – the vertical motions frequency, Hz; \( a_z \) – vertical accelerations, in fractions of the gravity
acceleration. The calculation result is the Motion Sickness cases number in personnel, referred to their total number on board the vessel (%) for fixed periods of time.

The second approach is based on the ISO 2631/3 recommendations (1985), according to which the curves regulating the values of the vertical accelerations as a frequency function, taking into account the effect time, are defined. These curves are approximated by the following dependencies (Stevens and Parsons 2002):

\[
a_z(t, f) = 0.5 \sqrt{\frac{2}{t}} \text{ for } 0.1 < f \leq 0.315; \quad (4)
\]

\[
a_z(t, f) = 0.5 \sqrt{\frac{2}{t}} \times 6.8837 f^{1.67} \text{ for } 0.315 \leq f \leq 0.63. \quad (5)
\]

The vertical accelerations values taken as a result of the calculation should be compared with the limiting curve taking into account the effect time. As a rule, a 2-hour standard is used.

The coefficient, taking into account the speed loss on waves, was calculated by the following relation (Molland, Turnock and Hudson, 2011)

\[
\delta V = \sqrt{1 + \frac{R_{AW}}{R_f}} - 1, \quad (6)
\]

where \(R_{AW}\) – additional resistance, caused by bad weather conditions; \(R_f\) – full resistance of the vessel in calm water.

For each of the variants of the platform with a small waterline area, the characteristics of navigability and operational qualities were taken.

As a result of the research, the authors determined the maximum dimensions of a universal platform with a small waterline area, at which it has an advantage over other types of vessels.

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FINDING THE WAY AT KRAKÓW GŁÓWNY RAILWAY STATION: A DETAIL OF CONFUSION POINT IN EYE TRACKER EXPERIMENT

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Keywords: eye tracker, pedestrian, passenger, transportation hub, Kraków, wayfinding

A wearable eye tracking device was used to study path and focus of 25 young people from three nations who were given the task of finding their way at the new main railway station in Kraków, Poland (the station is located underground, with access through a shopping gallery). The tasks are including finding the station entrance, locating a ticket counter, and going to a platform. A preliminary analysis demonstrated that the distances taken by the participants varied from 396 to 1026 m, while the shortest possible path was only 339 m. The time to complete the tasks varied from 267 to 754 seconds. Particular confusion was consistently noted in the station hall itself and this area is analysed herein in detail. The directional signs in that area inadequately point direction to the ticket counters, as was evidenced by majority of the test participants stopping and turning around in search for visual information. It took the participants between 33.8 and 401.3 seconds to pass the 73 m stretch between station entrance doors and their first sight of the ticket counters themselves. The average speed of participants in that area is decreased by 25%, to only 0.82 m/s. The results of these experiments can be used by engineers designing such transportation hubs to identify weaknesses in the location and clarity of signage.

Also it must be mentioned that in the past two decades, there is an interest in using eye tracking tools to investigate navigation tasks, but the literature still remains limited. The differences between males and females in reading of maps revealed no differences between sexes, but dissimilarities in giving directions based on the viewed maps indicated different cognitive processes [1]. Somewhat related work of directing and navigating in a complex indoor environment combined with assessment of the difference between attitudes and behaviour by realising a wayfinding tasks was reported several years later [2, 3]. This and similar studies were done under laboratory conditions. More recently, with development of more portable eye tracking de-vices, broad analyses in the field commenced. The difference between the objects that people saw during experiments in a busy urban environment and which they remember afterwards was reported [4]. More complicated field navigation experiment, including self-orientation, target search in the environment and on the map, route memorization and destination achievement, was recently reported [5]. A very interesting research work in context of this article was a study of Vienna’s main railway station done in 2017, where the usage of immersive virtual environment is presented as a new approach to analyse a visual attention inside infra-structural objects [6]. Assessment of pedestrian eye movement during navigation was reported very recently [7].
References


ASSESSMENT OF THE INFLUENCE OF TIME-OF-DAY ON CRASH RISKS: CASE STUDY ON INDIAN HIGHWAYS

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Keywords: Highways, crash risk, mixed traffic, time-of-day, reliability

For years, many studies relied on historical data of traffic crashes on roads as the basis of developing statistical models for crash prediction. However, a study revealed the fact that crash occurrences do not follow a linear relationship with the volume of traffic (Qin et al., 2006) and depend on several other contributing factors (Malyshkina and Mannering, 2010). In recent times, there have been a number of studies that reported the influence of time-of-day on crash risks (Doherty et al., 1998; Clarke et al., 2006); crash risk during night-time hours was found to be considerably high relative to other times of the day. Notably, a study indicated that higher frequencies of highway crashes in darkness are not due to the matter of visibility, but a consequence of more than a few behavioural factors (Clarke et al., 2006); for instance, drowsiness and fatigue, acute alcohol intoxication, disregard of traffic regulations etc. The current study observed that such risks exaggerate further in the event of mixed traffic composed of a wide range of vehicle types in terms of their static and dynamics. Accordingly, the study made an attempt to investigate the influence of time-of-day on crash risks of highways where the prevalent traffic is mixed in character.

For the purpose of investigations, crash data (10 years site specific data) was collected for highways with different configurations i.e. two-lane and multi-lane. Temporal variations in crash frequencies over time were also noted. Following such observations, traffic study (speed-flow) was conducted on those sections of highways at different time interval e.g. morning, morning peak, afternoon etc. and influence of time-of-day on driving behaviour was investigated. On the basis of a descriptive statistical analysis, the paper demonstrated the effect of time-of-day on driving behaviour. The study found that on two-lane highways crash risk is considerably high during daylight hours; this is primarily due to risk taking behaviour of driver population under mixed traffic situations particularly during daylight hours. During night-time they were however found to exhibit conservative attitude while driving. In was quite the opposite on multilane highways where over speeding is very common during night time resulting in higher crash frequencies and severity as well.

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References


Smart Solutions for Supply Chain Management
SMART CONTRACTS FOR ENTREPRENEURIAL COLLABORATION IN SUPPLY CHAINS

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Keywords: Entrepreneurial Collaboration, Smart Contracts, Blockchain, Supply Chains

Smart contracts are transactional scripts on the top of the blockchain technology that are created for executing and enforcing legal contracts. Self-executable they check contractual pre-defined conditions and automatically fulfil respective actions or transactions, respectively. Through this form of automation, the layers of middlemen can be reduced or even completely replaced. Accordingly, smart contracts bear the potential to decrease transaction and enforcement costs as well as process time.

In addition to this characteristic, we argue that smart contracts encase the potential to facilitate cross-organisational collaboration and their underlying business processes. This applies especially for logistics sector that is well-known for its dominating global players that try to limit entrepreneurial activities of small companies by using closed organisational structures and dedicated IT systems. The implementation of blockchain technology and smart contracts in the areas of logistics networks and supply chains support the integration of entrepreneurs and SMEs into trans-national value and supply chains by reducing high entry barriers and by weakening the dominating position of big players.

This paper discusses the research question how smart contracting and blockchain technology can facilitate the implementation of collaborative logistics structures and how the integration of SME sector into sustainable trans-national supply chains can be safeguarded. Our research is based on expert interviews and case studies from several EU projects with a focus on the ongoing projects “Connect2SmallPorts” and “CSHIPP”. The research results will showcase and assess this potential of using blockchain and smart contracting in the environment of trans-national and multimodal supply chains.
IMPROVEMENT OF LOGISTICS COMPANY MANAGEMENT BY EVALUATING DEVELOPMENT OF TECHNOLOGICAL INFRASTRUCTURE

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Keywords: logistics, technological, development of technological infrastructure, IT

A constantly changing market of the logistics services poses challenges to the logistics organisations and requires adaptation to the requirements of the service recipients and suppliers. More rapid processing of information gives a possibility to new options of communication with the suppliers and more effective organisation of distribution systems. Increasing information flows gain higher potential to influence management, structure, functioning and development of a company.

Development of technological infrastructure of organisations (Technological infrastructure – Accessibility and use of information technologies and telecommunications; Accessibility and deployment of state-of-the-art technologies) and Information & Technological Systems gives a possibility to service participants to exchange information, correct information flows and restore relevant information (via technologies), and this also raises new challenges to management of resources. Innovations, productivity and quality of production directly depend on the transmission of information and technologies. In order to successfully function in the current market, organisations have to purchase not one IT system or technology, but need to update system programmes on a regular basis, improve technologies or acquire brand new IT systems. The Article analyses peculiarities of the impact of the development of technological infrastructure and its usage as a measure designed for the development of logistics organisations and assurance of quality of the logistics services. A qualitative study resulted in the identification of technological infrastructure problems in the logistics organisations.
LOGISTICS SERVICE QUALITY OF DRY PORTS WITHIN LAND-BASED TRANSPORT CORRIDORS: A CASE STUDY “KHORGOS GATEWAYS”

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Keywords: Dry Port, Transport Corridors, Multimodal Transport, Logistics Service Quality

This paper aims to develop the assessment tool of logistics service quality of dry ports. Based on this, evaluations was aimed to assess the “Khorogos Gate-ways” dry port. Dimensions of assessment tool includes the availability of physical infrastructure; the reliability, safety and security, timeliness of operations and processes; the responsiveness of management and staff; the appropriating price; the comprehensive use of ICT applications; the multimodality and availability of value-added services. Based on the expert panel assessment, weights of these sub-dimensions were determined. Further, the semi-structured interview was conducted with the port-users, the quality of the dry port logistics services was assessed. According to the results of this study, practical recommendations for further research and development of the dry port of “Khorgos Gateways” were proposed.
IMPACT OF UNCERTAINTY FACTORS ON DECISION MAKING OF LOGISTICS MANAGEMENT

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Keywords: conditions of uncertainty, logistic decisions, management

The article is a contribution to the discussion on the possibilities of effective logistic decisions in conditions of uncertainty. Variable and unpredictable factors creating conditions of uncertainty affect not only directly on logistic processes (positive or negative impact), but also can be a determinant of making decisions. Logistic management, because it is referred to in the context of decision-making, is currently defined by the quality of management decisions taken, including such factors, which often constitute only partially quantifiable sets.

The main goal of the article is to show the strength of dependence between the occurrence of uncertainty factors and the type of decision. On the basis of decision-making theory, the types of decisions were defined, and then a set of factors that are most important for a given type of decision was selected.

The results of the analysis allowed determining the strength of the influence of uncertainty factors on making logistics decisions. On this basis, a catalogue of key decisions, including their types, was selected, but also were determined the effects of decisions taken under uncertainty.

The study and the results of the analysis should be treated rather as a voice in the ongoing discussion. Due to the unpredictability of some uncertainty factors, the research field in the discussed problem remains open.
THE IMPACT OF PROPER ORDER SCHEDULING ON ROBOTIC TRANSPORTATION SYSTEM EFFICIENCY

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Keywords: e-commerce, picking process, goods to person, order scheduling

The answer to the dynamic development of e-commerce market is using goods-to-person principle by enterprises increasingly often. Robotic transport systems used in this method create the need to choose a path, number of robots and taking into account order of assigning incoming orders to robots. In literature there are multiple proposals for the mentioned problems, which are evaluated based on path length, travel time through the path, consumed energy, average waiting time for the order execution, number of executed orders and total execution time of given orders by the group of robots.

Presenting the impact of incoming orders intensity and the order of assigning them to robots in the picking process is the aim of this article. Additionally, there is constant path finding algorithm and variable number of robots. Order intensity factor understood as time between incoming orders is not taken into account in literature, but it is significant due to gathering orders and limited time of executing them.

Results presented in this article are proof that using traditional way of assigning orders, where total number of orders in given amount of time is considered is wrong. It does not include irregular character of incoming orders to the system, which is important factor in e-commerce enterprises.
ANALYSIS OF THE INFLUENCE OF SOCIO-ECONOMIC FACTORS ON THE VOLUME OF RAILWAY PASSENGER TRANSPORT IN ŁÓDŹ REGION

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Keywords: railway transport, passenger transport, correlation coefficient, logistics

Article presents the determination of the weights of socio-economic factors affecting the volume of passenger transport on individual railway lines located in the Lodz region, as this is very important factor for development of regional logistics. Calculations were made for lines running from Łódź to Sieradz, Kutno, Łowicz Główny and Skierniewice. Passenger transport on these lines is operated by the carrier Łódź Agglomeration Railway. The transport data containing the number of transported passengers and the transport work done in 2017 were used for the analysis. A partial correlation coefficient was used to obtain values of weights of the analyzed factors. During the calculation of correlation coefficients, transport gauges were used as explanatory variables (dependent variables). The socio-economic factors influencing the volume of rail passenger transport on individual lines were taken into account, among others: the number of registered passenger vehicles per 1000 inhabitants, number of registered business entities, the value of fixed assets in business entities (this value reflects the size of business entities) and the number of people commuter for work. During the analysis, an additional, important factor influencing the volume of transport, which is the availability to the railway line for individual inhabitants was also determined. It is the value associated with the location of stations (stops) on the population centers (cities or villages). The availability parameter for an individual stop is affected by the distance of the stop from the city center, the condition of the network of roads leading to it (Lₜₜ), and the size of the population in which the stop was located (Wₜₜ). In order to determine the availability to the whole railway line, the availability of all stops located on it (Dₛ) is summed up. Next, the quotient of this sum and the length of the analyzed railway line is calculated. On this basis, the availability of the all railway line is determined, which is shown in the formula (1).

\[ D_L = \frac{\sum D_s}{L_L} \]  

(1)

To calculate the partial correlation coefficient, a correlation matrix, containing interrelations between all analyzed variables, was used. To calculate the algebraic complement of individual matrix elements and determinants obtained from the correlation matrix by plotting the rows and the columns an engineering calculation software Mathcad was used. During calculating the weights of particular factors affecting the volume of rail passenger transport on individual lines located in the Łódź region for each socio-economic factor, the absolute value of partial correlation coefficients (Cᵢ) was summed for the number of trains and the number of transported passengers. Then the summed value was divided by the number of analyzed gauges describing the volume of transport. This operation is presented by formula (2).
By dividing the received values $I_F$ for each socio-economic factor by their sum, it is possible to determine the weights of individual factors affecting the volume of passenger transport on railway lines in the Łódź region. The obtained weights can be used in the future during the multi-criteria analysis of railway lines in the Łódź region. These weights allow to avoid the subjective assessments of experts, that have been often used in previous analyzes.
COMPLEX DIGITAL MODEL OF TRANSPORT LOGISTIC SYSTEM TRANSFORMATION

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Keywords: digital transformation, life-cycle management, transportation logistic system, complex model, digital logistic infrastructure, assets efficiency

Overview of modern resources [1-4] gives an opportunity to point out one of the problems of forming a complex logistic model of an enterprise or a transportation-logistic system (TLS) in digital economy environment. To a great degree higher efficiency of a TLS depends on further integration of business processes as well as application of information-communication technologies, electronic services and production assets. Digital technologies become the main source of incoming investments and formation of a new logistic infrastructure.

As part of the transformation of the transport complex, "digital logistics" is aimed to respond to such challenges of the digital economy as the rapidly changing globalized and over competitive environment, the complexity of the operation of supply networks and TLS covering a wide range of enterprises, the rapid change in customer expectations and demands, and the limited resources of transport and logistics infrastructure.

In this case, digital transformation will be interpreted as a systemic change in the source of added value, the structural architecture of an enterprise’s TLS based on proactive management of the life cycle processes oriented to system engineering and the application of a new type of assets—digital assets, and a new type of capital—informational (intellectual) capital.

As the basic principles of adaptive management of TLS, the interaction of business processes and Internet technologies is considered. This interaction ensures the effectiveness of the basic elements of the system throughout the life cycle of digital infrastructure and IT services.

These factors require a revision of the existing approaches to the modelling of management systems in logistics, where the proacticity of the given systems (the ability to self-control, self-repair, self-defence, self-configuration and functioning in conditions of faulty situations) was not taken into account in calculations and solutions of improving efficiency and preventing incidents in modern market environment [5].

To increase the productivity of the enterprise system and increase the value of services, a complex 4D-model was developed that ensures the transformation of a logistics-oriented enterprise into a digital infrastructure. 4D-model is the interaction of the following modules: the TLS system architecture; management of production and digital assets and service; product lifecycle management/PLM; structure of business processes of the extended enterprise.

The modules contain data on various elements (products, assets, services) at different stages of the life cycle within a single digital infrastructure, IT services and business model. The cells in the modules are represented by the classification and description of the entities (objects) of the TL. The functioning of the 4D-model is supported by the requirements and the agreed description of particular models of elements, reflected in the PLM (Product Lifecycle Management) standards, the integration of technological processes, business processes and the TLS architecture.
This is the basis for the system transformation of the information infrastructure, digital data and IT services, organizational structures and products within the framework of an integrated client-oriented TLS. The implementation of these modelling principles is aimed at formation and development of a sustainable digital logistics infrastructure of a new generation of the 21st century [6].

The complex 4D-model and the methodology of proactive management form perspective scientific and methodological approaches to the design and operation of adaptive TLS throughout their life cycle, providing qualitative changes in the basic indicators.

References

FORMING THE COMPLEX MODEL TO RATE TRANSPORTATION INDICATORS IN SUPPLY CHAINS

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Keywords: transportation, supply chain, key performance indicators, reliability

The dominance of consumers’ market and the growing competition require new managerial methods and techniques improving reliability and supply chains’ efficiency at the expense of the reduction of the delivery time of cargo, preserving their integrity at the economically sound total costs.

The approaches to the evaluation of transportation in supply chains on the basis of key performance indicators (KPIs) differ. The analysis of research literature (Bowersox et al., 1996; Christopher, 2011; Chopra and Meindl, 2013; Heizer and Render, 2011; Krajewski et al., 2013; Wisner et al., 2012) on the topic shows that there is no unified methodological approach enabling to assess the influence of operational-economic parameters of transportation on KPIs of supply chains.

The major outcomes of this study are as follows. Firstly, this paper suggests the complex model of transportation in a supply chain that includes the model of Total Logistics Costs (TLC), productivity of transport operations, transportation time and transportation reliability. Secondly, the analytical dependencies to evaluate the KPIs of a projected supply chain have been determined by the authors using the integral method of economic analysis. Thirdly, the paper proposes the algorithm of determination of a supply chain transportation’s KPIs and the results of the calculations made on the basis of this tool.

References

THE APPLICATION OF BLOCKCHAIN TECHNOLOGIES FOR RAIL TRANSIT CUSTOMS PROCEDURES

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Keywords: logistics, blockchain, application, rail transit, cross bordering customs procedures

The railways had the lowest proportion of container China-Europe transportation at only 0.9% in 2016 (Eurostat, 2019). Project RETRACK (2012) suggests that costs, time, flexibility, reliability, quality, and sustainability of rail transportation are among the keys that may shift international transportation to rail. Our previous study (Sturmanis et al., 2018) demonstrated that the introduction of a hybrid or a public blockchain technology in a rail logistic chain is among the viable solutions that reduce costs for all actors while increasing their credibility and transparency. However, our further survey showed that stakeholders were likely to approve the introduction of the blockchain in other parts of the rail system but their own.

The customs and other state authorities demonstrated the most notable resistance to the change of the existing procedures, despite the CREAM (2012) study showing that customs have the lowest level of harmonisation in rail production systems amongst almost all of the border crossing proceedings on the way from Asia to Europe. This paper examines transaction and misalignment costs that appear in cross border customs procedures aiming to evaluate the significance of including the customs in a rail logistic blockchain.

The critical path method has been applied to detect the technological possibilities to reduce transit time on the Latvia-Russia cross bordering stations. The created transaction and misalignment costs have been compared with the transaction and misalignment costs that exist in a blockchain. We have concluded that the usage of blockchain technology in customs can improve cross bordering processes by reducing the total processing time of a train by up to 5.5 hours for each cross bordering station with comparable transaction and misalignment costs. This information suggests that customs should follow the technological changes taking place in the most important transit corridors.

References
RISK MANAGEMENT IN SEA PORTS – INSIGHTS AND TRENDS

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Keywords: logistics risks, risk management, seaports, projects, INTERREG, Baltic Sea Region

The Article was built on the material, insights and findings of the international project HAZARD – MITIGATING THE EFFECTS OF EMERGENCIES IN THE BALTIC SEA REGION PORTS 2016–2019. The Project was spurred on the fact that ports, terminals and storage facilities are often located close to residential areas, thus potentially exposing a large number of people to the consequences of accidents. The HAZARD project deals with these concerns by bringing together rescue services, other authorities, logistics operators and established knowledge partners. HAZARD project aims at mitigating the effects of emergencies in major seaports in the Baltic Sea Region. The types of safety and security emergency include, for example, leakages of hazardous materials, fires on passenger ships at port, oil spills in port areas as well as explosions of gases or chemicals. HAZARD brings together Rescue Services, other authorities, logistics operators and established knowledge partners. HAZARD enables better preparedness, coordination and communication, more efficient actions to reduce damages and loss of life in emergencies, and handling of post-emergency situations.

Project activities included a number of various studies, analyses and possible situation development forecasts. One of the main research topics with participation of Vilnius Gediminas Technical University was related to the current analysis of the risk management process in the main ports of the Baltic Sea Region. This Article is built on the research findings, and presents main risk classification and management aspects. A special focus is given to the analysis of the performance of regional ports, including a comparative port analysis according to the selected aspects.

According to the Article, the ports inevitably face ordinary risks and they can be referred to as technological risks: leakages, contamination of the port territory or area, accidents etc., as well as new risks: terrorist attacks or cyber security problems.
LOYALTY PREDISPOSED ALGORITHMS OF CHAIN MANAGEMENT SYSTEMS

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Keywords: development, performance, mesasystem, maintenance, efficiency

At the previous stage of research, the object of our study was a certain system, the so-called "well-organised system" (WOS). One of our findings worthy of note here, determined in the course of studying WOS, is that the development of a WOS per se carries the problem here. To be exact, the problem lies in the lack of organisation identified in the course of development (Kossiakoff, A. et al., 2011). To this effect, the object was distinguished in the course of consequential accumulation of knowledge about loyalty, the usage of which expanded in the setting of maintained understanding of the complexity of the identified object. As a result, the object revealing the essence of multi-user loyalty was described in terms of methodological grounds, which formed a base for the development of fifteen-node value hierarchy (VH).

Availability of a VH allows calculating the coordinates of a strategic position, the standing of which is evaluated in reference to the final predefined target. Evaluation of such positions is carried out using over three hundred reasonably selected attributes. Connection between neighbouring coordinates allows mapping a strategic trajectory, which is laid and studied in reference to the goal orientation vector. Aside from that deviations from the strategic course can be identified and an activity that has temporarily lost its sustainability can be restored. This has resulted in the development of the initial algorithm allowing the assessment of loyal aspect of an entire process in the setting of the accompanying aspects of the complete activity. Moreover, not only did the algorithm allow retaining the unity enabling one to overcome major circumstances, but it also led to the development of a procedure to the preparation of experts, or instructors, by now, in the domain of loyal maintenance. Such procedure was designed in reliance upon a gradual study of uncertainty, revealed first around loyalty, then within the setting of loyal maintenance by means of expansion of the Reichheld effect, and, finally, from the aspect of WOS (Reichheld, F. 2006). Results of application of the developed procedure have identified a number of its faults (Kelsina, D. et al., 2019).

In order to eliminate these drawbacks, one would have to build a hybrid hierarchy. This results in the formation in a new hierarchy of the value "Loyalty Predisposed Members" (LPM).

So, the LPM version is the final version of VH and implements a quality systemic transition from the state of being organised to predisposition. Thus, the issue is a mesasystem.

The LPM metasystem forms a base for the formulation of the topic of further study, which can be brought down to the following title: "Loyal Structures of Maintaining Organisations". Within the context the object of the study is stated. Further, a conceptually new articulation is presented. It is formulated within the framework of methodological rules used on the basis of a well-tuned VH.

Thus, we needed to perform sequential fashioning of six hierarchies and three transformations in order to obtain the final version of the VH, which provides a basis for further formulation of requirements towards a mesasystem and development of a management algorithm.

In the framework of the present study the steps related to the change of the research object, which led not only to the change of the purpose, corresponding tasks and approaches of the solution, but also the new approach of creation and maintenance of complex open systems
are constantly described in details. This approach is based on new conceptual provisions and methodological foundations. As a result, there is an opportunity to use a limited set of knots in order to select in a variety of attributes those that by violating the conditions of emergenicity and synergy, leads to a loyal unwillingness. This removes the uncertainty that has existed around the object for a long time and a new goal is formulated, which is focused on the training and education of professionals willing to make changes in the system without compromising its effectiveness. An important part of the study is the disclosure of three prerequisites that led to the new formulation of the study. This is a justification for the lack of organization that exists in WOS, which leads to a dependence on quantitative assessments. The paper shows that the instructor's excessive calmness in the field of transformation of the organization by overcoming complex situations requires not only effective means of verification, but also deep immersion in the mesasystem.

References

ENHANCING CONTROL SYSTEM SAFETY: IMPROVING SELF-ADAPTING ALGORITHMS

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Keywords: operational capability, metasystem, current state, goal formation, position

A new approach that allows drawing timely and objective conclusions about the operational capability of the organization has been proposed in the study. The content of the approach has been revealed through the presentation of the proposed measuring features of metasystems, supplemented by the estimated limitations of self-adapting systems (Kossiakoff et al., 2011). In the course of the supplementation, the effectiveness of the developed algorithms for restoration of the stable functioning of the enterprise has been investigated (Trompenaars and Coebergh, 2014).

The aim of the study is the modification of the control system under conditions of retention of qualitative standards of performance and quantitative measures of effectiveness. In this case, an objective measurement of the current state of the organization is carried out from the perspective of determination of its safety. The found measurement value, which is dimensionless, is correlated with the coordinate of the metasystem (Kazina and Kopitov, 2019). As a result, the reliability of a conditionally set standard is no longer necessary, since we are talking about an objective task of a standard expressed by the value of a dimensionless quantity correlated with the coordinate of the final point, and which can be easily converted into a value equivalent in the future.

In accordance with the set goal, several tasks that are revealed from the perspective of a safety and a particular planning horizon should be solved. In the course of resolution of the set tasks, a multi-stage procedure was developed. The presence of a developed procedure allows implementing the transition to an objective specification of the standards. The procedure was built with the due consideration of the requirements for metasystems. The self-adapting procedure was built by using the developed hierarchy of values, on the basis of which the coordinate of the strategic position was calculated. The position calculation algorithm required the collection and processing of business information, allowing to take into account the conceptual features of the metasystem and the specifics of decisions made within its composition. The value of the current coordinate, calculated in points, was converted into the cost equivalent. According to the value, the level of revelation of the organization’s potential relative to a reasonably specified standard was determined. In addition, the places of inconsistencies arising in cases of destruction of the value were identified.

In the framework of the conducted study, three fundamental points should be distinguished.

First, the use of the certainty property of the metasystem for an objective measurement of the current state of the organization makes it possible efficiently to combine new ideas with old beliefs. In such a case, by using the goal of the metasystem as the final destination, it is possible to compare the found measurement value relative to it. The calculation is carried out within the established boundaries of the strategic field under conditions of experimental comprehension by converting the well-known models into unique methods.

Secondly, it is shown in the paper that the high level of uncertainty that is characteristic of open systems does not allow to ensure objective transformations in practice. Therefore, new applications of a self-adapting nature were proposed, built on the supplementation of the technology of Well-Organized Systems with the functions of the Diffuse Systems. As a result, a
monitoring system for the assessment of large-scale circumstances throughout the entire life cycle of their manifestation, which is adapted, both to the determination of the operational capability of the organization in general and to measurement of the consequences of specially designed programs for the improvement of activity of the organization.

Thirdly, the combination of the measuring features of the metasystems and the estimated limitations of self-adapting systems revealed the cause of the problem, which is goal-setting, which as the final result allowed us to develop the desired algorithms that restore the organization’s functioning sustainability by providing timely and objective conclusions about its performance.

References

Smart City
ESTIMATING THE SUSTAINABILITY IMPACTS OF AN URBAN CONSOLIDATION CENTER IN A MEDIUM-SIZED CITY

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Keywords: social cost benefit analysis, sustainability disciplines, sustainability enablers, impact assessment

One of the most important sectors in a city’s economy is the sector of transportation and distribution of goods. However, such operations cause several problems such as traffic congestion and environmental deterioration. Urban Consolidation Centers (UCC) are logistic platforms aiming to rationalize goods distribution by minimizing the above impacts, satisfying at the same time stakeholders’ interests, such as public authorities, supply chain stakeholders (retailers, carriers and suppliers), consumers and civilians.

This paper proposes establishment of a UCC in the vicinity of the city of Volos, where trucks unload their cargo and cross-docking activities take place before goods are directed to the urban area for final distribution. Urban distribution is undertaken by green vehicles, which are assumed to replace conventional delivery trucks, in order to reduce operational costs and impacts in the city from urban distribution movements. As Volos is a medium sized city, delivery of goods by cargo bikes and green vehicles is foreseen.

Traffic and environmental impacts that result from the operation of the new system are compared with the case before the UCC establishment. All impacts are monetized into a social cost benefit analysis and the overall quantified benefits are estimated.

References

SHARED-USE OF AUTONOMOUS TRANSPORTATION SOLUTIONS: HOW READY ARE WE FOR THEM?

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Keywords: Public transport; Carpooling; Car-sharing; User acceptance; User survey

Shared-use mobility implies those transportation services which accommodate multiple users in various schemes. Systems used in this case, include low to high occupancy vehicles, such as public transit; taxis, vans, special vehicles; bike sharing; scooter sharing; car sharing; ride sharing (car-pooling, van-pooling). They can be used for one way or round trips, carrying passengers and even accomplishing goods deliveries. Shared-use vehicles provide an effective way for facilitating traveling, eliminating the need for owning vehicles and minimizing traffic volume, congestion and all resulting impacts.

Autonomous vehicles are an emerging technology, with aim to increase the transportation system performance. Multiple direct benefits are assumed for autonomous vehicles. Researchers discuss mostly travel time, cost savings, environmental friendliness and safety improvements; they also touch upon legal, liability and privacy issues. The validity of these studies and their conclusions relies heavily on the accuracy of the assumptions related to the acceptance of such systems by the users and their choices for making their trips. User acceptance is determinant for the success of technological innovations, since the actual acceptance of new technology defines the users’ intention to use this technology [1].

The scope of this paper is to assess the knowledge, attitudes, beliefs and intentions of the future autonomous vehicle users, considering also socio-demographic attributes and mobility needs. The data analysed are based on two surveys; one, conducted on car-pooling and car-sharing systems, thus addressing the private traveling; the other, conducted on public transport systems. Both surveys examined the expected benefits, the users concerns and their willingness to use the systems, under different levels of automation, based on international standards [2, 3]. Taking into account that fully automated private or public vehicles are not widely available in market, with the exception of some examples of fully-automated trams and a limited number of other pilot implementations, users’ acceptance was determined and analysed a priori, meaning that the majority of the respondents evaluated the shared autonomous transportation solutions before testing them [4].

Analysis identified similarities and the differences between private and public autonomous vehicles and assessed the level of possible usage by the travelers.

References
IMPROVING THE BRANDED SERVICE OF VEHICLES WITH INTELLIGENT DRIVER ASSISTANCE SYSTEMS

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Keywords: failure prediction, dealer and service network, automotive industry, maintenance and repair planning, spare parts supply planning

The dynamic development of road transport and high competition in the global markets force automobile manufacturers to introduce new approaches to ensuring their competitiveness. To ensure customer loyalty, their trust to brand, the company should improve not only the quality of produced vehicles, but also the quality of the subsequent service support.

The quality and efficiency of repair and maintenance largely depend on the availability of necessary spare parts, free stations and workers, as well as on the degree of logistic processes’ efficiency. Under these conditions, development of the concept and science based approaches to the creation and implementation of intelligent system for service planning plays an important role. For this, it is necessary to ensure a stable interaction of the production, logistics and service systems. Herewith, online data exchange between these systems is necessary in order to plan and organize all internal processes taking into account their interaction, integration and complexity. Online data on the vehicles’ state should be the basis for predicting the need for spare parts, planning their production at the manufacturer, delivery to service centres, as well as scheduling the loading of service stations. In addition, the accuracy of diagnostics and the timeliness of identifying potential failures play an important role.

Today, many leading automakers are introducing intelligent driver assistance systems when producing new model line-up of vehicles: Scania (Scania official website), DAF (DAF official website), MAN (The MAN Group official website), Mercedes (Mercedes-Benz Uptime Customer Portal). The Russian automobile manufacturer KAMAZ (KAMAZ official website) also started developing such a system. DAF uses the DAF Connect system, which allows tracking anytime and anywhere the real-time performance indicators of the driver, as well as the condition and performance of the vehicle. The Scania Fleet Management System (FMS) allows developing an optimal service schedule individually for every vehicle and notify the customers of the next maintenance date, coordinating the optimal visit time. The Comfort24 System offered by MAN allows predicting vehicles’ maintenance intervals. The Mercedes Benz Uptime System is connected to the network online, which allows preventing failures, manage repair and maintenance works and provide online technical support to customers when performing repairs.

Each of the systems offered by these companies has its advantages and disadvantages. Creating an integrated information space with a common database will allow timely responding to non-standard situations and more accurately planning maintenance. In this article, we propose an intelligent system for service planning that ensures the interaction of these systems based on online data exchange and processing.

The existing failure prediction systems and methods are considered in the article. A systematic approach is needed to organize effective information interaction between the logistic, production and service systems. The authors have proposed an improved algorithm for the Dealer Service Center (DSC) operation which will minimize vehicles’ downtime while waiting for repairs and will help to predict the need for spare parts and production facilities of the DSC.

The developed intelligent system for service planning consists of the following modules: data collection and storage module, data analysis module, DSC’s scheduling module, spare parts
forecasting module. The initial data are: electronic passport of the vehicle, information on failures during operation, information on authorized suppliers and their reliability, as well as about the dealer-service network parameters.

**References**

THE INFLUENCE OF COUNTDOWN TIMERS ON SAFETY AND DRIVER REACTION TIME AT INTERSECTIONS WITH TRAFFIC LIGHTS

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Keywords: Countdown Timer, Driver Reaction Time, Statistical Analysis

The article discusses the subject of countdown timers. Contradicting views about their occurrence and diversified results of scientific research, as well as initial legal obstacles connected with their appliance in Poland were the motivation to make an attempt to conduct own research. On its basis, an attempt was made to answer the question if countdown timers improve traffic in the city. Next, if they ultimately contribute to faster driver reaction time. The attention was focused mainly on driver reaction time during traffic light change from red with yellow to green. Drivers’ gender was also discerned. The observations had been made at two intersections in Opole (one with countdown timers and the other without them). The received results were analyzed and an attempt was made to compare the obtained road user reaction times. The obtained results have been completed by statistical analysis based on hypothesis testing (with the use of the null hypothesis). Its aim was to examine in detail the amount of driver reaction time at intersections with countdown timers and intersections without countdown timers. In the result of conducted statistical analysis, it was ascertained that countdown timers influence driver reaction time when the signal changes from red and yellow to green.
SELECTION OF THE METHOD TO PREDICT VEHICLE OPERATION RELIABILITY

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Keywords: operation reliability, failure prediction, Logical-and-Probabilistic Method, Failure Mode and Effects Analysis, Fault Tree Analysis

One of the main factors affecting the competitiveness of vehicles is their reliability at every stage of the “life cycle”: design, production and operation. Vehicle’s technical health’s monitoring and diagnostics is very important during the operation stage, since it is the necessary tool to collect data on the spare parts failures. This allows erasing causes of possible failures and predicts vehicle’s life time.

There are different methods of the reliability analysis of complex systems. The most widely used all over the world are Fault Tree Analysis (FTA) (Wang et al., 2019; Lokuge et al., 2019), Failure Modes and Effects Analysis (FMEA) (Sun and Deng, 2017; Lombardi, 2011), and Monte Carlo Simulation (MCS) (Kowsari et al., 2019). Moreover, to make decisions in various fields, researchers also use various combinations of these methods (Ma et al., 2014; Guo et al., 2014): for different problems under consideration, different approaches are more efficient. The authors of the paper in addition to the well-known FTA and FMEA, consider the logical-and-probabilistic method (Makarova et al., 2019) to predict vehicles’ operation reliability.

To select the most suitable of these methods, authors have used the statistics of failures received from the dealer and service network, and from the engine manufacturer’s reliability department. The logical-probabilistic approach was chosen, on the base of which the authors propose an Intelligent system to improve the operational reliability of the vehicle’s engine.

The paper presents an Intelligent System to increase operational reliability of the vehicle’s engine based on the logical-and-probabilistic method for the vehicle’s failure prediction. The results of the study show that the use of a developed Intelligent System based on the logical-and-probabilistic method reduces the total number of engine failures, as well as the number of failures of the crank elements. This means that possible failures can be predicted more accurately, as well as prevented by using a defect encoder in conjunction with a logical-probabilistic method, as well as to ensure timely availability of necessary spare parts. At the same time, conditions must be created for the timely updating of initial information, its prompt processing and storage of ready-made solutions.

This is especially true under the conditions of the transition to Industry 4.0 which implies the production of models according to customer requirements in mass production. And this will lead to the emergence of a large number of vehicles’ models and modifications. Under such conditions, there will be a constant need for reliable information and, if it is insufficient, probabilistic methods should be used.

References


THE ANALYSIS OF THREAT DEFINING LANGUAGE USED IN THE EU OFFICIAL TRANSPORT SECURITY AND SAFETY DOCUMENTS IN THE LATEST ENGLISH EDITION

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Keywords: safety, security, EU documents, language, synonyms

This paper analyses European Union safety agencies latest regulations deal with the different transport modes – The European Aviation Safety Agency, The European Union Agency For Railways, and The European Maritime Safety Agency, which are responsible for the aviation, rail and maritime sectors respectively, and European Union Road Safety latest documents. The analysis was conducted on the bases of synonyms for words “security” and “safety” according to Webster Dictionary of English language. Also, the author carried out a semantic manual analysis for words that could be included in the extended list of safety and security threats. The aim of the research is to find out the degree of importance of specific security and safety issues based on the statistical usage of synonyms for words “security” and “safety” as well as phrases included those words.

The methodology used by the author includes the following: 1) literature review on the research topic; 2) European Union (EU) regulation documents quantitative and qualitative analysis. In the paper, the author analyses the list of the latest EU documents in the field of transport safety and security, including Regulation (EU) 2018/1139 of the European Parliament and of the Council, of 4 July 2018 on common rules in the field of Civil Aviation, EU Strategic Action Plan on Road Safety, and Directive 2005/65/EC of the European Parliament and of the Council of 26 October 2005 on enhancing port security.

As findings the author proposes a table of degree of importance of specific security and safety matters based on the statistical usage of synonyms for words “security” and “safety” as well as phrases included those words.
Sustainable Transport Development
RISK ASSESSMENT OF LOGISTICS HUB DEVELOPMENT ALONG GREEN TRANSPORT CORRIDORS: THE CASE OF PALDISKI PORT

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Keywords: Logistics hub development, Green Transport Corridors, Risk Management, Green Controlling, Multi-stakeholder Governance

One keystone in the evolution of sustainable transport solutions is the considering of the green transport corridor concept with its transnational and multimodal character and the involvement of the heterogeneous group of stakeholders that require multi-level approaches in the phases of implementation, management and governance.

The authors were involved in the creation of a hub development strategy of Paldiski Port in Western Estonia aiming to link the port via a new railway bypass to Muuga Port around Tallinn representing the end of the “Rail Baltica” Green Transport Corridor. The purpose of the hub development of Paldiski Port was twofold. First target was the preparation of an enlargement of the logistics service portfolio in order to improve the competitiveness of Paldiski towards Finnish ports. Second aim was the integration of Paldiski Port as a future hub in the “Rail Baltica” Green Transport Growth Corridor.
Digitalisation and the steady increasing wide range of related novel technologies are currently and in the next years of high topicality in policy, business and research landscape. This rising interest evolved over the last decade and resulted into different use cases of these data-enabled technologies in distinct industries like manufacturing, IT and logistics. Thereby, digitalisation is often regarded as the saviour for managing the challenges in further growing globalisation, competition and environmental issues as well as customer-oriented supply chain focus.

In order to keep pace with the fast changing market environment and customer needs, especially small and medium-sized ports have to take action now, since their bigger counterparts are already heavily investing in digital technologies, as they have recognised the added value. First empirical results from the EU-project Connect2SmallPorts have shown that small ports in the South Baltic Sea Region have a common and high interest in digitalisation, but often do not know about the already existing wide range of digital technologies and the arising benefits. Accordingly, in accordance with the INTERREG project Connect2SmallPorts, the present research aims to develop a digital auditing tool in order to discover the digital status of small and medium-sized seaports. The research builds upon an extensive literature review and further utilises innovative approaches and combines theoretical concepts as well as project-gathered practical insights. The research results will showcase a target-group-oriented (here: small and medium-sized ports) digital auditing tool that will be applied in the further course of the EU-project Connect2SmallPorts.
A WEB-BASED ECONOMIC DECISION TOOL FOR ABATEMENT INVESTMENTS FOR SHIPPING INDUSTRY

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Keywords: Clean Shipping, ICT Solutions for Appraisal of Abatement Technologies, Stochastic Modelling

Shipping industry is facing new challenges in recent years. After the global financial and economic crisis of 2008–2009, low freight rates forced the maritime sector to develop new business models to cope with economic pressure. Parallel, new environmental regulations set additional requirements to the business that culminated 2015 for Northern Europe with the implementation of Emission Control Areas (ECA) in North and Baltic Sea. The compliance with ECA regulations confronted the shipping companies with a number of costly decisions that ranged between the use of expensive compliant fuel and the installation of abatement technologies. Meanwhile, this challenge appeared for all ship operators due to the Global CAP that will be valid from 2020.

A promising approach to tackle the economic decision problems is to apply evaluation techniques from financial engineering that are successfully used in stock trading. This paper shows evidence of the dynamic Discounted Cash Flow (DCF) approach contributions on the evaluation of capital budgeting investment projects, and its applications in assessment of financial performance through an empirical study on basis of fuel prices variations in maritime industry. This paper has a threefold aim (i) overcomes the static assumptions of long-term asset valuations, (ii) provides insights to the use of a new technique in the investment valuation literature, and (ii) aims to take into account the value of flexibility and potential dynamic model of fuel prices. In this regards, we advocate Monte Carlo Simulation (MCS) to quantify risks and uncertainties associated with the feasibility of investment and to value capital budgeting in the framework of the real options theory. Shipping companies aim to maximize benefits by taking the investment with positive net present values (NPV) in order to create shareholder value. The dynamic approach is applied by introducing a random walk in the model predicting future fuel prices. Hence, we empirically examine the joint stance of the DCF and the MCS analyses so to approximate the true NPV of project by incorporating a set of dynamic variables that directly affect the anticipated cash inflow-outflow valuations.

The authors took place in the EU project “EnviSuM” that focused on the assessment of the SECA regulations on Baltic Sea Region (BSR) and especially on its maritime business. Since ship operators are usually not familiar with financial engineering tools, the “EnviSuM” project developed as one main output a “web-based economic decision tool” for abatement technologies.

The web-based tool is publicly accessible and was created by using the php programming language. The paper provides coherent results about the web-based tool from an economic point of view. The results are empirically validated by expert interviews, surveys and case studies that were executed between 2016 and 2019 in the frame of the “EnviSuM” project.
ANALYSIS OF TEST RESULTS FOR DEVELOPED TECHNOLOGY OF DIESEL BUS CONVERSION INTO ELECTRIC BUS

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Keywords: Electric Bus, Converted Diesel Bus, Test Results, Energy consumption, Efficiency

During the last years, the issue of the conversion of city diesel buses to the electric buses has become significant. This is the evidence made by several recent sources of information, such as Lightning Systems, a global developer of zero-emission solutions for commercial fleets to repower diesel buses with battery-electric systems. The first demonstration vehicle will be on the road this summer and will give the bus more than 200 miles of all-electric range [1].

An important step ahead of us is the state of California, where much attention has been devoted to electric vehicles for a long time and significant financial support has been provided for many years. Even more in March, the U.S. Environmental Protection Agency awarded more than $8.7 million to replace or retrofit 452 older diesel school buses in 32 states as a part of its Diesel Emissions Reduction Act program [2].

The research presented in this paper is devoted to the developing of technology of diesel bus (DB) conversion into electric bus (EB) which is suitable for operation in small and medium size cities and can significantly reduce the harmful impact on the environment. This paper represents the methodology and results of technical and economic analysis applied for testing developed technology of DB conversion into EB. It compares and summarizes the initial obtained results from theoretical technical and economic mathematical models with those obtained experimentally by testing created EB on the dynamometer test bench, on the testing track and under real conditions on the specified urban public transport routes [3].

Main tasks of this study are to compare testing data with the initial estimations for the following indicators:
- TCO;
- mechanical efficiency of the reduction gear;
- electromechanical efficiency of the traction drive;
- acceleration;
- regeneration effectiveness;
- energy consumption;
- battery charging efficiency.

Initially, the technical and economic viability of the proposed technology was estimated to convert a regular DB into an environmentally friendly EB. Several models were developed to assess basic technical indicators, and the obtained results were used as input variables in the model of Total Cost of Ownership (TCO). The basic parameters were initially selected based on expert estimations and market analysis [4].

The results obtained experimentally and calculated deviations from the initial estimates confirm the technical suitability, economic viability of the developed technology of DB
The highest deviation of -5.06% is observed in the initial calculations of regenerative braking. This can be explained by the fact that the testing of mechanical power losses was higher than originally adapted.

Acknowledgements

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APPLICATION OF AHP METHOD IN CONDITIONS OF THE REGIONAL AIRPORT

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Keywords: Regional Airport, Air Transport, Multi-criteria Decision Making, AHP method

The consequence of social and economic changes in the Czech Republic included liberalization of air transport. After the politically bipolar Europe ceased to exist and the Czech Republic joined NATO, there was no need to keep so many military airports, which were therefore converted into civilian airports.

Regional airports development used to be very slow which was related to their function. Contemporary pressure on air transport from regional airports to the world is very significant and most of the airports are trying to form or extend their current portfolio of new regular lines.

The right choice of transit or final destination is very important for the development of a regional airport, especially from the point of view of the possibility of transporting passengers to the destination, from where they can best proceed to the world with one transfer. The selection of such suitable destinations can be done by applying the AHP (Analytical Hierarchy Process) method when the airports will be explored as variants through the criteria, which will be determined as important parameters for selection.

Acknowledgements

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ASSESSMENT OF NOISE LEVELS CAUSED BY FREIGHT TRAIN WAGONS: CASE OF PANERIAI RAILWAY STATION

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Keywords: Train Wagons, Noise, Railway, Transport

Railway noise is an important environmental and public health issue. Train noise can be a type of environmental noise. When a train is moving, there are several distinct sounds such as the locomotive engine noise and the wheels turning on the railroad track. Freight trains can send loud train noise into neighborhoods.

EU member states have different limits on environmental noise pollution. As a rule, tests that are within these limits are only carried out with new infrastructure or large-scale reconstruction.

The article presents research at Paneriai railway station, measuring the noise level at two points A and B near people's house. The studies were carried out in places where there were no noise suppression measures. Measurements of noise levels were made during the evening and at night by a freight train passing by station and stopping at the station.
Intelligent Transport Systems and Telematics
INFRASTRUCTURE-FREE SENSOR PLATFORM FOR MULTIDIMENSIONAL OBJECT AND MOTION ANALYSIS

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Keywords: mobile sensor platform, infrastructure-free, active stereo vision, lidar sensor, AMR, drone

This paper examines the use of mobile sensor systems used to track objects and people. The research was conducted in the subproject “fast athletics” in the cluster project “fast actuators, sensors and transceivers”. “Fast athletics” is intended to develop control loops with short latencies, high sampling rates and synchronicity in a heterogeneous sensor structure for performance diagnostics in sports. Although this project concentrates on sports, the findings are transferrable and applicable to logistics and supply chains. Tracking in this project requires highly adaptive, infrastructure-free mobile sensor platforms. A mobile sensor system, consisting of multiple unmanned aerial vehicles (drones) and autonomous mobile robots (AMRs), singly or in combination, was developed in order to track and analyze athletes or objects modularly, optically and wirelessly. The operator-controlled (tactile steering) or autonomous (noncontact assistance) mobile sensor platforms are equipped with multimodal sensors, e.g. RGB-D cameras (near field), Lidar sensors (far field) and radar sensors.
LASER MARKING OF A SMALL SIZED QR CODE ON A PLASTIC SURFACE

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Keywords: ABS plastic, lasermarking, QR code

The development of telecommunication technologies is claims ever higher parameters of quality and reliability to communication cable connectors. Modern production of connecting cables has the need to identify connectors by their technical parameters. The proposed labelling system greatly simplifies the quality control system and increases productivity. Using laser marking technology, it is possible to mark the QR code on the surface of an object. This two-dimensional code contains hidden information related to the given object. The requirement of the producer is to label not only the product group but also the specific technical characteristics of each small product, which are unique for each product. Using the Rofin Powerline F20 Varia laser system, experiments were carried out where the goal was to find the necessary laser system parameters that would allow quality laser marking on the surface of an ABS plastic. The purpose of the experiment is to mark the QR code, the size of which must not exceed 3.5 mm and the information contained must be read by the help of a smartphone. In order to achieve the objective pursued, experiments were carried out in search of the optimal frequency-power relation, line step and frequency relation, and finding the optimal parameters experiment was carried out in cell sized symbols of the quantity of symbols by which the experimental markings of a size not exceeding 3.5 mm were defined, thus finding the maximum amount of symbols that could be encoded in QR code, while maintaining the ability to scan them using a smartphones camera.
ETHNICITY CLASSIFICATION SYSTEM BASED ON HUMAN FACE PICTURE

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Keywords: ethnicity, face recognition, softcomputing, neural networks, CNN

Depending on the region, many theories explain how people became a part of our world. Most popular theories describe us as a creation of higher forces. Earth was designed to be our own to rule and conquer. Other, however, describe people as an effect of evolution. This is a more scientific approach, as biology and archaeology show how everything changes adapting to the environment and being exposed to the forces of nature. No matter how we appeared in the first place, Homo Sapiens had to follow the example. Because human race started to explore and inhabit various, more and less friendly territories, millennia spent in Tundra, Africa, Asia and such, took their toll on the gene pool of people living there, the results of what are visible not only in culture and habits, but also the appearance. Aspects connected to that are race and ethnic group. While these two definitions are sometimes mistaken as equal, race can actually be specified as a subcategory of ethnicity, with ethnicity being defined as a concept of categorizing people according to similarities in social background or differences from other clusters of people. Physical appearance can often connect to one’s self identification with nationality, subculture or even race. And physicality will be the topic of the paper.

Nowadays multiple fields of technology use the possibilities image processing offer. As much as gender or facial expressions are broadly documented, ethnicity recognition is yet to be widely explored. Companies still try to find new ways to raise sales numbers. It is often connected to strong marketing tactics and policies relying on extensive product targeting. Most products build their promotion on the specification of audience they try to reach. Sometimes it is gender, other times age and sometimes ethnic group. With visual systems recognizing shoppers mood already in use, same cameras connected to different software could use customer oriented advertisement on the screens around the venue. Police forces might also find use in the system. As far as facial recognition systems are already an established tool, not every description of the perpetrator is detailed enough for the system to produce satisfactory result. Basing on the victims description, while validating data with delinquent’s known locations, ethnic group can be an appearance feature used to gather a base of potential suspects for the victim to point at.

We try to investigate whether a selected softcomputing method, more precisely convolutional neural network, is capable of handling the task of ethnicity recognition. The problem focuses on whether a network, using picture of interested person, can estimate ethnic group this person comes from. A thorough research was conducted to pick suitable basis for the softcomputing system, finally deciding on convolutional neural network. The decision was made based on a wide range of usability neural networks as a whole represent, with convolutional networks specialization in image based learning.

The system apart from neural network basis contains of image processing module. The module works in two ways: network training and manual validation mode. For training image processing loads images one by one, scaling it to proper width and height. In manual validation version the module is also responsible for recognition and cutting face off from the loaded
picture, before required scaling. Training of the network has been done with restriction to pictures containing only faces, positioned in the middle of the photo. This omits ears and hair. It was assumed that the system will be used using colour-scale cameras. This way the feature of skin complexion can also be used for prediction.

The paper also contains description of each selected ethnicity group and how it is affected by geographical position. Moreover we present a state of art regarding chosen problem with their advantages and disadvantages. The created system is showed describing tools used, technical background, alongside the structure and the implementation. Finally the reader can find achieved results with final conclusions and ways of further improvement.

References

OPTIMIZING THE PIPELINED DES CRACKER IMPLEMENTED IN CONTEMPORARY POPULAR- GRADE FPGA DEVICES

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Keywords: DES cracking, pipelining, FPGA efficiency, Spartan-7 device

Data Encryption Standard (DES), the first standardized and widely used symmetric cipher for computer data, is now obsolete as a data protection method but a task of its cracking is still a popular benchmark testing computational efficiency of various dedicated high-end parallel processing systems. In the paper we propose an original, highly pipelined architecture of an FPGA-based DES cracking engine where each cipher round is split into two pipeline stages in order to maximize speed of operation. Implementation results generated by the tools illustrate progress in the cipher cracking systems which was made possible by advances in new FPGA technologies. This work can be considered as an extension of our previous developments (Sugier, 2019). The basic, 16-stage pipelined organization (denoted as P16) which turned out to be the most efficient one in that analysis served as a point of reference in evaluation of the new proposal of this paper.

The new cracker design (denoted as P16x2) was based on the idea of intra-round pipelining: with each DES round divided into two pipeline stages their total number in the complete decryption path increased to 32. Since the DES round processing is relatively simple with half of the state copied without any transformation, the only place where a combinational propagation path could be split into separate stages was between the DES f() function and XOR operator adding the round key to the function’s output. In addition to such a new pipeline register another two ones had to be added per each round for synchronization of the paths without any processing which generated new routing nodes and complicated the implementation process. Furthermore, decomposing circuitry of one DES round into so small (and fast) fragments made the rest of the cracker framework too slow to keep up with the speed that the decipherers could achieve. The two additional modifications in the cracker organization were required in plaintext comparison and key generation.

The paper reports size and speed parameters obtained after implementation of the P16x2 design in the two largest Spartan-7 devices: 7S75 and 7S100. Splitting simple logic of the DES round into two pipeline stages brought some challenges which made difficult to achieve the expected improvements in the final speed of the system because size increase introduced by extra pipelining to some extent counterweighted reduction in the raw maximum clock frequency. Nevertheless, it was shown that doubling the number of pipeline stages as proposed in the paper to the total of 32 (after careful application of other fine-tuning modifications in the overall cracker framework) offers 25% increase in the final speed of the cracker in the Spartan-7 75 device and 18% increase in the 7S100 chip.

References
APPLYING MODERN TEXT PROCESSING TECHNOLOGIES TO IMPLEMENT A SELF-LEARNING MARKETPLACE BY USING CLOUD SERVICES AS AN EXAMPLE

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Keywords: cloud-service, NLP, NLTK, self-learning, machine learning, artificial intelligence

Marketplaces have become common ways to provide systems for commercial interactions between users and vendors. These systems must be maintained and supported by people adapting the system to the user’s behavior. Users behavior can be tracked by analyzing the text inputs users do while they search for a product. The goal of this research was finding a way to automate this adaption process with considering the inputs of the users on a marketplace prototype for cloud services. To fulfill this task, modern methods of text processing such as stemming, and lemmatization were suitable. The problem has been solved by applying a self-learning algorithm combined with a self-updating database. The system now provides direct feedback recognizing wrong input. As a result, future research could be the further development of the self-learning system to a self-adapting system.
THE FUTURE APPROACH TO SIMPLIFY THE CLOUD-SERVICE MARKET USING A STANDARDIZED DESCRIPTION LANGUAGE

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Keywords: primary data acquisition, cloud-computing, cloud-services, standard, description, categorization, methodology

The market of cloud services has been growing continuously during the last years. However, the market is not transparent. There is a complex pool of different cloud services potential users must understand, before they decide to acquire specific products. Additionally, each cloud provider uses its own name for a cloud service. The question that will be answered in the following research paper is: How can cloud services be described in a standardized way? To achieve the goal of answering this question, a basic form of statistical analysis has been chosen. Summing up the results, it is possible to standardize the description of cloud-based IT-services. Therefore, it is only necessary to find the right adjective/verb and object combination for a specific service. Using this new description methodology, the complex market could be structured in the future. Further research can combine the enhancements of the description language as well as the question: How could this new standard be transferred into; and accepted by the market.
LIFECYCLE OF TEMPORARY FACTS IN DECISION MAKING SYSTEMS

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Keywords: intelligent systems, production model, decision making systems, knowledge bases

Modern intelligent systems based on production model of knowledge including decision making systems accumulate large amounts of rules and facts. Ones of the typical decision making systems are situation centers created at large airports and assisting in the emergency situation elimination [1]. Big knowledge bases yield some serious problems of combinatorial complexity of reasoning from the rules in the knowledge base. An alternative approach to decision making is case based reasoning, but the applicability of precedents is a separate decision making problem because an assessment of similarity of the current problem and the problem solved by the precedent is not a trivial task [2].

In this paper, an original approach to reducing the complexity of inference from knowledge bases is proposed. First, we define two classes of facts in the knowledge base: events and states. Events are the primary facts that cannot be changed or deleted. Events change the states of objects so a chain of events relaying to an object generates changes of the status of the object. So, status is a secondary or temporary fact driven by on events. For instance, if the events are marriage, divorce or death of the spouse then marital states of the human are single, married, divorced and widowed. After the rule applied to the event the new temporary fact is available for queries and the long reasoning from rules is not necessary. Of course, this approach is reasonable only for temporal entities where state of an object could be changed during the lifecycle of the decision making system.

Acquisition a fact instead of the inference from rules needs some additional memory but significantly decreases the time. On other hand, the extracted fact can be not actual if a new event occurred, but the status has not yet changed because the status update procedure has not run. The problem becomes more intense for distributed knowledge bases what knowledge bases of situation centers belong to.

One could propose three ways to provide the actuality of temporary facts. First, to run a procedure of temporary facts update each time when an event occurs to check all the rules using this fact in their conditions and then check all rules using the consequents of these rules, etc. This is an analogy of forward reasoning and it could involve virtually all the knowledge base to this process. Second, when the inference process faces a fact marked as temporary it propagates back to the rules yielding this fact and inspects all possible non-processed events. Third, the processing all the incomed events is fulfilled by a schedule. This problem is a typical task of knowledge base maintenance [2].

The paper discussed pros and cons of the approaches to ensure actuality of temporary facts listed above and the recommendations for the knowledge base maintenance are proposed.

References

THE METHOD OF AGILE PROJECTS SUCCESS EVALUATION USING MACHINE LEARNING

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Keywords: neural networks, product life cycle, customer satisfaction, Python

The aim of the study is to identify opportunities for improving the efficiency of designing and managing processes in agile software projects, as well as timely analysis of existing problems affecting the success of the project. The object of study is the planning processes and the processes of agile development of software products. The subject of the study is the evaluation of successful completion and success forecasting of software projects with agile development.

In accordance with the goal, the following tasks were solved within the framework of the research:

- Analysis of projects models with a agile development cycle, the creation of an original model with the allocation of development phases and the establishment of a list of actions performed in a cycle with agile development, in order to identify factors affecting the ultimate success of the project.
- Development of an original method for estimating and forecasting the successful completion of software projects with agile development using Machine Learning.

Over the past ten years, a look at assessing the success of a project has changed significantly. Previously, it was mainly focused on a triple constraint, which meant that if the project met the requirements of time, cost and volume, it was usually considered successful. Recently, the idea that stakeholder satisfaction plays an important role in the success of a project has been widely recognized (Serrador & Turner, 2015). After an extensive survey of 1386 projects, the authors found that the project’s effectiveness was moderately strongly correlated (a correlation of 0.6 with an R-square of 0.36) with the overall success of the project. This means that other factors also make a significant contribution to the overall success of the project. Possible other factors presented by the authors can best be described as meeting the expectations of interested parties in terms of product, performance and risk.

The paper suggests a model of a flexible software development process based on the proposed factors influencing the success of the project, which was used to predict the success of the project on the knowledge of their quantitative characteristics. The parameters of this model were determined using machine learning methods based on multilayer neural networks (Loy, 2019). Libraries for the Python language were used.

References

Transport and Energy
INFLUENCE OF CHANGES IN STRUCTURAL AND MECHANICAL CONDITION OF ALUMINUM ALLOYS CAUSED BY IMPACT-OSCILLATORY LOADING ON THEIR FATIGUE LIFE

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Keywords: modern aircraft, rocket structures, aluminum alloys, impact-oscillatory loading

Aluminum alloys D16-CzATW and 2024-T351 are widely used for the manufacture of modern aircraft and rocket structures. During operation, they are subjected to complex types of loading, in particular, cyclic loading. Therefore, the task of extending fatigue life of such materials is very relevant. In this paper, new experimental data on the influence of changes in the structural and mechanical condition of aluminum alloys caused by impact-oscillatory loading on a wide-range change of their fatigue life are presented. Previously it was shown that due to the realization of dynamic unbalanced processes (DNP) in aluminum alloys due to impact-oscillatory loading, it is possible to significantly increase their fatigue life at load frequencies of 15 Hz. However, the problems of determining the optimum intensity of introducing force impulse energy into aluminum alloys for the guaranteed increase in their fatigue life remained unresolved. Based on previous studies of the authors on the effect of DNP on changes in physical and mechanical properties of materials under subsequent loading as a parameter that characterizes the intensity of introducing impulse energy into the alloys, the dynamic deformation of alloys in the process of DNP realization - \( \varepsilon_{\text{imp}} \) – was chosen. In this study, the range of changes in \( \varepsilon_{\text{imp}} \) on flat specimens with the width and thickness of the working part 10 mm and 3 mm, respectively, was adjusted from 3.7 to 10%. This is explained by the fact that for small values of \( \varepsilon_{\text{imp}} \), the dissipative structure is not yet able to be formed under the realization of DNP in alloys, and at \( \varepsilon_{\text{imp}} \) values greater than 10.0%, the margin of plasticity on the ascending branch of the stress-strain diagrams of alloys is virtually exhausted. The maximum length of yielding areas in alloys is recorded at the level of 3.6%. In some cases, in the presence of the areas of yielding, the tooth of yielding also appears. To evaluate the observed changes in the structural and mechanical condition of alloys due to impact-oscillatory loading on the fatigue life of aluminum alloys, additional tests of batches of similar specimens under cyclic loading were conducted on a high-frequency resonance testing machine RUMUL TESTRONIC 50kN. Test modes for both alloys were as follows: soft mode of loading; cycle asymmetry coefficient \( R = 0.1 \); maximum cyclic loads \( F \) were 13.2 kN; 12.0 kN; 11.1 kN; 10.2 kN, respectively; indicative test frequency was 110 Hz. As the basic characteristics, the number of cycles before the destruction of alloys in the initial state was selected. The comparison of the results of previous impulse introduction of force energy of different intensity into the alloys with the results of cyclic tests (by the parameter \( \varepsilon_{\text{imp}} \) and the available signs of the formation and manifestation of yielding areas in the alloys) revealed the basic regularities in the change of the alloy durability at an approximate resonance frequency of 110 Hz. The established experimental fact that an increase in the loading frequency from 15 Hz to 110 Hz significantly reduced the effects of increasing the durability of alloys due to the preliminary impulse introduction of force energy is also important.
FEASIBILITY STUDY ON THE USE OF ENERGY STORAGE SYSTEMS TO REDUCE THE ENTERPRISE ENERGY CONSUMPTION COSTS

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Keywords: Energy storage system, NPV analysis, market electricity tariffs

In many regions, competitive electricity wholesale markets have emerged. Participants in these markets are energy producers and load aggregators. As a result, aggregators are able to buy energy at day-ahead and real-time power markets (Xu et al., 2011). In the Baltic region, such a trading platform is the Nord Pool Spot, which results of trades are available for analysis (Nord Pool Spot market data, 2019).

The article describes the possible ways to reduce the cost of electricity consumed by the enterprise by redistributing consumption depending on changes in tariffs over time. Organizational changes include changes to work schedules, and the technical approach is based on the use of an energy storage system (ESS) and its circles “charge/discharge” optimisation by linear programming method. If the relevant agreement with an aggregator is, then the end user has the opportunity to redistribute organizationally or technically its load (energy consumption from the grid), to achieve more consumption for the hours with lower prices (Krivchenkov et al., 2019). This will provide lower energy costs for the users.

The effectiveness of the energy costs reduction projects, estimated on basis of economic criteria (economic feasibility study), is the main aim of this study. It is important at the stage of initialization of the project. Popular metrics of the efficiency of investments in business is ROI (Return on Investment). The feasibility study of both methods is carried out using the example of price regulation in Latvia. An analysis of net present value (NPV) shows that the application of ESS for redistribution of workload (with existing tariffs setting structure, variations and costs of ESS) is economically inefficient for different energy consumption levels, at least in existing conditions of legislation (rules of price setting) in Latvia.

References

ROUTED ENERGY DISTRIBUTION NETWORK CONCEPT WITH ELECTRICAL ENERGY ROUTER

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Keywords: energy distribution system, energy management, energy router, smart grid

To support increasingly high penetration of intermittent renewables, such as solar and wind power generation, and distributed generation, many regions are planning to add new high capacity transmission lines. These additional transmission lines strengthen grid synchronization but will also increase the grid’s operation equipment requirements and protection complexity, and furthermore will be very costly. The conventional approach of providing electricity from the point of generation, for example a power plant, deals with a high power and therefore requires very powerful equipment. Every sub-station is responsible for providing power to designated region or area. If a sub-station goes down, the area is left without energy supply. Such case is highly undesirable, that is why to ensure energy supply there should be reserve sub-stations or more complex fault-tolerant equipment. Modern energy grid has been developed with extensive interconnections with the purpose to improve reliability through redundancy. However, this interconnection increases the risk of wide area failures because any imbalance can be propagated quickly over an ever-widening area [1].

As the electricity generation is shifting to renewable sources, the grid infrastructure faces multiple challenges: intermittency and variability of a wide range of renewable sources, geographically distributed generation, bi-directional power flow and a need for energy storage systems for meeting demand response requirements [2, 3, 4]. A high penetration of renewables requires profound changes to the current energy distribution system. The conventional grid is increasingly becoming a bottleneck for expanding the share of renewable energy sources, because of its rigid architecture, which is built around centralized energy source.

On the other hand, we have more recent and rapidly growing computer network systems. It passed many stages before it became so much developed and effective as we see it nowadays. It is time to make a big step to the future in the energy network and energy distribution as well. It might be hard to believe but energy networks and computer networks have much in common. Both have customers that are connected to network cables, and in both cases the main task of the network is to provide the requested flow. On one side it is information, on the other – it is energy. The same as computer network customers, houses in energy network can either request energy for their needs or generate and send energy to the network when there are photovoltaic panels, wind or other generators installed.

In this paper we show how achievements from computer world can contribute to energy network and quickly bring it to the next generation of energy management. We introduce a novel concept of a new Energy Router device. This device is capable of smart energy routing between renewable power sources, residential homes, and other interconnected elements in the smart grid.
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References

THE DYNAMIC ADJUSTMENT CAPABILITIES OF THE PLASMA ELECTROLYTIC OXIDATION PROCESS USING HIGH-SPEED POWER INVERTER MICRO MODULES

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Keywords: plasma electrolytic oxidation; GaN transistor; power inverter; algorithm; dynamic adjustment

The method of plasma electrolytic oxidation (PEO) increases the depreciation and corrosion protection of mechanisms and structural elements of transport and technological equipment by several tens of times.

PEO is an electrochemical process of oxidation of the surface of non-ferrous metals and their alloys in electrolytic plasma with the aim of obtaining thin (0.1-10 mkm) depreciation coatings on the working surfaces of parts (Suminov et al., 2010; Jayaraja et al., 2017). The structure and characteristics of PEO coatings depend on the base material, the composition of the electrolyte and the conditions of their formation. The mode of operation, technical parameters and circuit design of the sources of technological current and devices for controlling these sources are important factors. The pulsed anode-cathode mode of the PEO is the main mode, but the shape and parameters of the voltage pulse and the magnitude of the current in this mode have a significant effect on the characteristics of the oxidized coating.

To perform PEO it is necessary: to form a power pulse of complex shape (the pulse voltage is hundreds of volts, and the pulse current is several amperes); operatively limit the current in the breakdown of the oxide layer and ignition of the arc; adjust the parameters of the current pulse to produce an oxide layer with the required properties. For example, to obtain high hardness oxide coatings by the REO method on metals such as aluminum, magnesium and titanium, the voltage pulses should have durations of about 100 μs. The improving the characteristics of PEO coatings it is possible if the current regulators of technological current sources to create using the modern power high frequency transistors, such as the SiC MOSFETs and GaN – transistors. In (Saltanovs, 2018) it is shown that when using these transistors it is possible to generate the power pulses with a specified duration, but to perform dynamic adjustment of a complex pulse shape by analogue method is impossible.

The purpose of this study is to determine the possibility of dynamically adjusting the PEO process using modern power transistors and an adjustment algorithm developed and implemented taking into account the characteristics of the PEO process.

Analysis completed of the pulse voltage shape and parameters needed for pulse anode-cathode mode of PEO process. It was proposed to use discrete pulse control (Chen, 2012) to perform PEO process and the repetition frequency of the control pulses should be in the range of 200-300 kHz. To research of the proposed principle of formation of a voltage pulse for the PEO process, we have developed and implemented:

- the high-speed power inverter micro modules on GaN transistors GS66508T (GS66508T, 2015);
- an algorithm of discrete-pulse adjustment of PEO process the specialized signal microcontroller dsPIC33FJ64GS610 from MICROCHIP (dsPIC33FJ64GS610, 2015);
- a test bench of the PEO process.
During the research of the dynamic adjustment capabilities of the PEO process we determined the influence of the operating frequency of power inverters of micro modules on the pulse shape of the oxidation voltage and on the shape of the oxidation current. This influence is illustrated by time diagrams of voltage pulses and current pulses of the dynamic adjustment capabilities of the PEO process.

The main results of this work are following:

- the power inverter micro modules created on GaN transistors GS66508T have better frequency and thermal characteristics in comparison with similar modules based on SiC transistors C3M0065090J and eGaN EPC2035 transistors (Saltanovs, 2019);
- algorithm for discrete-pulse adjustment of PEO process is designed and implemented using a signal microcontroller;
- possibility of dynamic adjustment of PEO process using created micro modules with the right choice of operating frequency is shown;
- the operating frequency of the PEO process control system should be close to 300 kHz.

References

REDUCING THE IMPACT OF VEHICLES ON THE ENVIRONMENT THROUGH THE MODERNIZATION OF TRANSPORT INFRASTRUCTURE

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Keywords: Transport Emissions, Sustainable Transport, Simulation

Transportation, in connection with the development of technics and technology, globalization of production and the growing need for mobility, has become an integral part of people’s lives, ensuring the transport of goods and passengers. Modern production, industry, construction, agriculture, trade can not function without the active use of road transport. Automobilization, along with positive effects on the economy and social development, has negative consequences, including a significant number of road traffic accidents with damage, as well as harm to the health of people, including the dead and wounded. In addition, motor transport has a negative impact on the ecological state of the urban environment in the form of noise pollution and air pollution by exhaust gases. Currently, road transport is the largest source of emissions of pollutants. At the same time, the volume of emissions from motor vehicles, both relative in the structure of emissions and absolute, increases every year due to the growth in the number of vehicles and the volume of road transport. Over the past decades, the environmental performance of motor vehicles has improved significantly. However, this did not lead to a decrease in the emission of pollutants, as there is a continuous increase in the level of motorization. So, in the world there are more than 1.2 billion cars. According to forecasts of the World Bank, by 2050 the world fleet will double. Obviously, road transport will have an even greater burden on the environment.

Modern scientific research and practical experience allow us to explain the causes of all the listed negative phenomena and make recommendations for reducing and eliminating the negative effects of automobilization. The state of transport infrastructure and control systems has a high impact on the parameters of traffic flows and the degree of their impact on the environment. Well-functioning infrastructure facilities reduce transportation costs, affect the speed of passenger and freight traffic, reduce capacity constraints and increase the availability of transport services to the public. In this regard, the development and application of scientifically based methods for improving the efficiency of road traffic management in urbanized areas by upgrading infrastructure facilities in difficult sections of the road network, in particular, optimizing traffic light control parameters, is an actual problem and is of considerable theoretical and practical interest. At the same time, it is of interest to identify factors influencing the choice of the optimal solution for developing a universal technique.

The article analyzed the problem sections of the road network of two large cities, similar in scale and geometrical location and having certain specific features. Data from full-scale studies of the structure and intensity of the city’s traffic flows were obtained. The data on the intensity of the traffic flow, its composition by vehicle type, density of the traffic, speed of movement, traffic delays, as well as the intensity of the pedestrian flow were recorded and calculated. On the basis of the obtained data, the calculation of emissions of pollutants from road transport in the sections of road network was made. The authors built a simulation model...
of sections in a simulation software based on a discrete-event approach using a traffic library. Performing a computer experiment on the model showed that with the existing parameters of traffic flow and road infrastructure, traffic jams occur at the sites, which is consistent with the results of field surveys. Activities for the reconstruction of these sites were proposed. Performing a computer experiment on a model with new parameters showed that in these areas there is a significant potential for improving the parameters of traffic flow and, consequently, reducing the negative impact on the environment.
Aviation
AIRPORT CHARGES POLICY AS A TOOL FOR ACHIEVING COMPETITIVE ADVANTAGE IN THE AVIATION MARKET

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Keywords: Airport, Charges, Competitive Advantage, Nordic Region

Air transportation plays an important socio-economic role, and an airport, as part of the transportation system, is a significant component of the national infrastructure. The airport is not just a provider of aviation services, whose activities are regulated by the state, but is a self-sustainable commercial complex with its own business goals and development strategy aimed at the growth and economic efficiency of operations. Strengthening its position in the Nordic region is the strategic goal of Riga International Airport. Competitive advantage in airport charges policy should contribute to the accomplishment of this strategic goal - Riga Airport should be the first choice for airport transit passengers, airlines and regional enterprises. However, although Riga Airport has a competitive advantage in charges, which are the lowest among the major competitor airports (Helsinki-Vantaa and Stockholm-Arlanda airports), it does not have a market leader position in Northern Europe.

The aim of the paper is to analyse the charges policy of Riga International Airport, RIX in comparison with competitors in Northern Europe and to develop recommendations for improving the charges policy as a tool to enhance the competitive advantage of the airport in the Nordic region. To achieve this aim, the authors consider the theoretical aspects of competitive advantage as the basis for the accomplishment of the strategy, analyse the position of Riga Airport among competitors, including passenger traffic as well as on charges for a particular aircraft. To fulfil these tasks, the authors use such methods as analysis and collation of materials of scientific research and periodicals, comparative analysis and costing. The conclusions and recommendations for improving the charges policy are addressed to the management of Riga International Airport and can be taken into account when developing strategic plans for the airport development roadmap.
ANALYSIS OF NAVIGATION SYSTEMS FOR LANDSIDE TRANSPORT PROCESSES CONTROL

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Keywords: Aerodrome, Landside Transport Control, Communications, Navigation

The increasing demand of air carriers' services, as an integral part of this process, airports, leads to an increase in the intensity and density of traffic both in the air and in the ground space of airports. In order to provide an appropriate level of service for aircraft and vehicles at the airfield, in conditions of limited space and time limit, new procedures and improved ground traffic management and control systems are being implemented. Such systems relate, for example, A-SMGCS (Advance-Surface Movement Guidance and Control System). New and prospected methods for servicing aircraft have to provide the required capacity and safety, taking into account weather conditions and time of day, traffic density and aerodrome design. This becomes possible only with usage of advanced technologies and a high-level integration of various technologies. The secondary surveillance radar (SSR) mode A/C radars used for a not very long time were replaced by Mode-S, GNSS, ADS-B, GBAS and MLAT. Being as the basis of the implemented global concept of Communications, Navigation and Surveillance/Air Traffic Management (CNS/ATM), adopted as the navigation standard of the 21st century, each of these systems has its advantages and disadvantages. The quality and reliability of such systems and methods depends directly on the timeliness, accuracy and volume of information received from all vehicles involved in the servicing of aircraft at the airport. In modern conditions, it is not enough to have information only about the location of the object, which can be obtained from the primary surveillance radar (PSR) or SSR mode A/C. It is necessary to have a complete picture of the current situation at the airfield, that is, not only the exact coordinates of the moving objects, regardless of their location (the open part of the aerodrome or indoor hangar), but also speed data, moving direction, route, and sometimes altitude.

The paper provides an overview of prospective methods of management and control of ground traffic at aerodromes and the objective for researching these methods through the usage of computer simulation is formulated.

References
INTRODUCTION OF THE NEW ARRIVAL AREA NAVIGATION SCHEME FOR MINSK NATIONAL AIRPORT AIRFIELD

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Keywords: airspace, «trombone», PMS, scheme, optimization, streamlining

For a long time the streamlining of arriving aircraft at many airports in the world was carried out by well-rooted and not very safe methods. Vectoring was used everywhere and little attention was paid to any optimization. With the improvement of the operational environment caused by the widespread introduction of the PBN concept, including in the Republic of Belarus, everything gradually began to change. At the moment, priority options for modernizing the processes of priority formation are certain schemes, which, depending on their structure, allow the merging or stretching of the trajectory, thereby streamlining air traffic.

Vectoring is the primary way to streamline inbound aircraft traffic today. There are also holding patterns that allow you to delay the flow of aircraft, thereby increasing throughput. The efficiency and safety of the streamlining methods get worse due to the increase in the number of aircraft serviced, bad crew awareness, excess radio communications, complete dependence on human capabilities and the lack of clear systematization. In the context of continuously growing demand for ATS and the desire to meet modern international standards, the necessity of modernization was clearly indicated. It was decided to take such a step by introducing new arrival schemes based on RNAV («point merge system» or «trombone») as part of the implementation of the PBN concept in the Republic of Belarus [1, 2].

«Trombone» used to control the incoming air flow is mainly an RNAV procedure known as «RNAV transitions» [3]. It’s application, as well as any other procedure of this type, is determined by the sequence of waypoints, restrictions on speed, altitude, direction of a turn, as well as navigation aids [4]. But, taking into account the weak «trombone» scalability, which can be carried out either by introducing additional waiting zones or by a limited increase in the fragments of the scheme (way extension points), it was decided to consider one more alternative of arriving flows streamlining. According to the Eurocontrol study, «PMS» has some fundamental advantages over many ways of streamlining in suitable conditions.

References

MANAGEMENT OF FINANCIAL STABILITY IN AIRLINES: PROBLEMS AND SOLUTIONS

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Keywords: Financial stability, Management, Solvency, Capital, Airlines

Financial stability of the enterprise as object of management acquires special relevance in conditions of development of the market relations. The investigation of process of ensuring financial stability of the enterprise demands an integrated approach to studying, as well as developments of management concepts as a set of theoretical and methodological bases, which are insufficiently deeply studied now. Objective of the research is the analysis of financial stability management in aircraft companies and development of actions for improvement of their financial position. The basic concepts, principles, functions of financial stability management of the enterprise in integrated market environment are formulated by authors in the article. The structure of management and control system of financial stability in aircraft companies is considered, the integrated technique of financial stability management in airlines is developed, features of management of financial stability in the enterprises of the aviation sector are revealed. Results of the research can be used in practice of European and Asian airlines.
ANALYSIS OF PASSENGER PURCHASING BEHAVIOUR
AND REVENUE INCREASE POSSIBILITIES
FOR NON-AVIATION AIRPORT SERVICES

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Keywords: airports, travellers profile, purchasing behaviour, factors, dependence

With the advent of globalization, the global tourism industry has also expanded multiple times. Air transportation became dominant in transcontinental and intercontinental travels and continue to be more competitive for shorter trips in the regional markets. Annual World Airport Traffic Report (ACI, 2018) forecasted that global average annual growth rate for the period 2017–2040 for passenger traffic will be 4.1% and for aircraft movement around 2%.

It is stated that non-aviation sector plays an important role in airport general development. Internationally about 40% of the airport revenues in 2016 come from the non-aeronautical commercial activities (CAPA, 2019). From one side non-aviation sector should provide to passengers pleasant and comfortable stay at the airport, and on the airports side, it can improve passenger satisfaction and gain supplementary revenues, creating a “win-win” situation.

Multilingual shop communication and surrounding atmosphere are the two most important factors that positively influence the purchasing behaviour of airport shoppers (Geuens et al., 2004). Influencing the purchasing behaviour of airport shoppers also require the implementation of well-thought marketing strategies that are designed while keeping in the view the airport’s location as well as the shopping behaviour of the frequent types of travellers.

Europe is considered as an expensive traveling destination, making it is easier for travellers to spend additionally on airport shopping areas. The large size of the European region makes it difficult for marketers to focus on specific types of travellers, as travellers from all over the world visit European countries for pleasure, entertainment, travelling, adventure, and business. Airport shopping is not only considered cheaper than normal shopping within the city malls and markets but is also considered relatively easier, as majority of the travellers have ample amount of time between check in and boarding. There were identified three main services cape factors, which influence duty-free shoppers buying behaviour – functionality, attractiveness, and convenience (Park, K.-S. and J.-W. Park, 2018).

The paper purpose is to analyse the case study - non-aviation sector at Riga International Airport that also plays an important role in its general development (RIX, 2019). Riga International Airport ended the year of 2018 with a significant increase in served passenger amount - 7.06 million passengers, which is almost 16% more than a year before (RIX, 2019). The volume of the flights at Riga Airport is increased by 11.5%, which meant that Riga Airport was handling 83.5 thousand aircraft in 2018. Airport Riga already invested in its facilities development and recently started terminal expansion stage 6 (RIX, 2016) and one of its main activities is building a connection with Rail Baltica station, which will bring not only more passengers and travellers, but also opens revenue growth opportunities. Rail Baltica station, the growth of the air travels and passenger traffic together provides possibility to provide positive client experience and increase airport income from non-aviation services in the check-in zone and on the airport terminals.

For deep understanding behaviour of passengers and developing the model of dependences between different factors (shop location, flight time, etc.) and consumer activity, it
is necessary to know the profile of travellers. That’s why key findings of this case study are build based on the Riga International Airport travellers’ population profile distribution and behaviour, with the aim to identify travellers’ group, who will generate revenue grow in commercial areas from non-aeronautical services.

References

AIRPORT TYPOLOGY AND DEVELOPMENT PATHS

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Keywords: aviation management, airport development, Airport City, airports classification

In the modern era of globalisation air flights are no longer the luxury item. People travel for different private and business goals, and the passenger flow grows every year. According to the Statista (2019) data for the last four years the global air passenger growth was 7-8% per year, whereas in 2019 it already is 5% (on preliminary results). Meanwhile, also increase the number of people who spend time in the airport waiting a flight that makes airports change and develop as attractive space.

The development of the airports could be focused on different aspects of the airport scope of activities. Thus, some airports are actively developing aviation capacity – increasing aircraft count and quality, looking for the new flight directions, moving the status from local to international. For example, Atlanta Municipal Airport was actively developed in 1960s and became an international airport in 1971 (Hartsfield-Jackson Atlanta International Airport, 2019). In turn, another airport government is more concentrated on landside development. Additionally, to the already existing shops and restaurants, airports are getting their own exhibition halls, business and entertainment places, hotels, and become not just a transit point but sometimes even trip destination.

The current paper is focused on commercial work of airports, and considers its potential development vectors, as well as the factors affecting the choice of the development direction. The detection of such factors and reasons can help to systematize possible development paths of airports.

The typology of the airport could be based on the different aspects – size of airports, cargo tonnage, geographic position, functional role, nature of traffic, utilisation and technical characteristics, ownership and network position (Mayer, 2016; NASEM, 2019). The classification also can include passenger-related variables: number of gates, annual volume of different (international or domestic) destination passengers (Adikariwattage et al., 2012). Certainly, there were developed also classification methodologies encompassing different aspects and parameters of the airports. However, such methodologies are focused mostly on one particular region. Thus, in the paper (Malighetti et al., 2009) are considered the Europe airports classification, but Suau-Sanchez et al. (2015) were focused on the US airport classification system based on the FAA typology.

There are a lot of different classifications, and choice of the appropriate system could be rather difficult. The current paper tries to systematize most popular airports classifications, as well as find the strengths and weaknesses and point out the gaps for observed systems.

References

THE ANALYSIS OF THE STANLEY’S CONTROLLER PERFORMANCE IN THE PRESENCE OF THE STEERING ANGLE DISTURBANCES

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Keywords: Stanley’s control law, performance, autonomous ground vehicle, disturbance, steering angle, oscillations

Currently, autonomous ground vehicles (AGVs) are making a noticeable appearance in the publicity and various possible benefits of the autonomous technologies are being widely discussed. While taking into consideration these possible benefits, in the society it is assumed that the AGVs should positively improve the traffic safety by reducing the number of accidents, increase the mobility for various social groups of people, reduce traffic congestion and emissions, etc.

The actual realisation of such benefits is a major motivation to accelerate the development and research of the AGVs technologies. Respectively, while seeking to ensure a safe and accurate autonomous movement of the vehicle, a properly tuned controller plays a crucial role. However, a proper tuning of a controller for various driving conditions in most cases becomes a very complex task, which requires specific knowledge about the performance of the selected control law.

Due to above mentioned reason, this research presents the detailed analysis of the Stanley’s controller performance in the presence of the autonomous vehicle steering angle disturbances. The performed analysis is based on the theoretical simulations, which considers different Stanley’s controller gain parameter values, different sizes of the steering angle disturbances, different movement trajectories and velocities of the autonomous vehicle. Thus, the presented analysis describes the relation between the velocity of the autonomous vehicle, the Stanley’s controller gain parameter, the output parameter, i.e., the steering angle values, generated by the Stanley’s controller, and the path tracking errors. The results of this analysis can be successfully applied, while developing a tuning approach for the Stanley’s controller.
Innovative Economics
HOW COMPUTER SYSTEM VALIDATION CONTRIBUTES TO PERFORMANCE IMPROVEMENT IN LATVIAN SME

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Keywords: Computer system validation, Firm performance, Resource-based theory, SME, Medical device industry, Descriptive statistics, Inferential statistics

This research paper deals with the current situation regarding the implementation of Computer System Validation (CSV) in European medical technology companies. The CSV is a complex evaluation process to validate all IT systems (hardware as well as software) in a company, whether these systems are appropriate for the production of medical devices or not. Since 2016, this process has been required by various DIN standards and regulations in Europe for the manufacture of medical devices. While larger companies often have enough resources at their disposal to outsource this process, small and medium-sized enterprises (SMEs) in particular have problems with implementation because they often have insufficient resources in terms of time, personnel and budget (Schönberger & Vasiljeva, 2018). The aim of this research is to identify determinants and impacts of the CSV on the firm performance and to determine the associated challenges, especially for SMEs.

With the focus on Latvian SMEs from the medical technology industry, a survey was conducted on the current status of the implementation and execution of the CSV. For this purpose, a previously developed research model (Schönberger & Vasiljeva, 2018) served as the basis for the survey as well as for data collection. To implement the research model, a total of 63 constructs were included in the questionnaire. Contact data for Latvian SMEs in the medical technology industry were collected via the Lursoft database. In order to increase the acceptance of the questionnaire, the questions were translated into Latvian by a translation agency. A total of 78 SMEs could be identified who were asked to participate in the survey via email. As one of the results it can be stated that the medical technology industry in Latvia is mainly characterised by micro-enterprises with less than ten employees and that there are significant gaps in the understanding and implementation of the CSV.

A previous literature study by the authors (Schönberger and Vasiljeva, 2019) revealed that no research could be identified that justified changes in firm performance due to the implementation of CSV. Thus, this research provides new knowledge and understanding of the implementation of CSV to foster firm performance in SMEs. However, the research shows some minor limitations. First, with a sample of only 78 companies, there is no claim to representativeness of the survey. Second, as only SMEs from the medical technology industry were considered, the results cannot be transferred to large enterprises or enterprises of different industries, e.g. the pharma industry. Finally, as the focus is on Latvian SMEs no conclusions can be drawn about the applicability of the results to SMEs in other EU countries.

The practical significance of this research is mainly based on the potential application of the survey results in SMEs in the medical technology industry. In this context the focus of the utilization of the research results lies on the introduction and practice of CSV, the improvement of the quality management and thus the compliance with regulatory requirements as well as the formulation of business strategies for enterprises located in the respective industry segment.
Acknowledgements

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References

INVESTMENT POLICY DEVELOPMENT AND PROBLEMS IN LATVIA

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Keywords: investments, investment policy, economic development

An effective attraction of investments in national economy is a key factor, which will provide favourable conditions in order to perform structural changes to national economy, regional development and promotion of technical progress that is why investments in public and private sector conduce development of national economy and will provide conditions to increase competitiveness of country in overall.

The purpose of research is to evaluate the investment processes in Latvia before and after the global financial crisis, revealing investment-related problems, as well as to calculate the level of investment desired, which would ensure Latvia's GDP growth on average 5% per year, according the target set by the NDP.

In analyses there are used different qualitative and quantitative analysis methods, such as scientific literature and empirical research analysis, modelling tables, charts and schemes, calculations of average and relative values, grouping, comparisons and other. There are used Latvian and international scientific researches and publications on investments and its role on economic growth process, which are available in Central Statistical Bureau of the Republic of Latvia (the RL) and Eurostat data bases, reports from the Ministry of Economics of the RL, also the World Bank, the OECD and other international organizations researches and information available in internet.

As a result of research there were defined directions of investment policy, essential obstacles which delays investment attraction in Latvia.

References
E-COMMERCE MARKET IN THE BALTIC COUNTRIES: STATE-OF-THE-ART AND TRENDS OF DEVELOPMENT

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Keywords. e-commerce, Latvia, Baltic States, international trade

The development of information technologies and means of communication provided an opportunity to form a new economic environment, the intensity of use of which has become a feature of the functioning of modern business. A pronounced tendency of business development was the emergence of new forms of interaction between economic agents and the implementation of business processes with a predominance of electronic business relations.

Now, it is possible to implement business processes, making maximum use of Internet technologies, as the sphere of circulation allows, since a large number of organizations work here, and a substantial share of capital is turning. Investments in information and communication technologies, connectivity and growth of e-commerce have become key elements in expanding e-business and the digital economy. The Baltic countries are currently developing very rapidly in the digital economy. Estonia is not far behind the main players in the e-commerce market, but in Latvia and Lithuania this type of business is spreading at a much slower pace.

This study identified key elements and factors that determine the need for e-commerce and affect its performance in the context of the dynamics of the world economy and modern business. To accomplish this goal, the following tasks were solved: the definition of e-commerce was given in the context of the article; shows the dynamics and main trends in the development of e-commerce in the Baltic States, its place in international trade. An electronic survey was conducted among specialists in this industry to identify factors that impede the active development of electronic commerce in Latvia, as well as to determine the prospects for the development of electronic business.
BENCHMARKING OF CORPORATE COMMUNICATION MEASUREMENT STRATEGIES IN MAJOR ENTERPRISES BASED ON THE VALUE-BENEFIT ANALYSIS

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Keywords: Corporate Communication, Measurement, Benchmarking, Major enterprises

Communication measurement is a useful way to exam where communication works or doesn’t work within a company’s strategic goals; it helps managers to make smart managerial decisions. A company with effective communication strategy has higher return to shareholders, more motivated and engaged employees, higher value of an intellectual capital created inside the corporation.

The goal of the paper is to benchmark contemporary ways of measuring corporate communication management performance and to define what measurement methods are most appropriate for major enterprises. The research subject of this study is communication strategies (methods) for measurement of specific performance of relevant information through management reporting system passing from traditional information technologies approaches to digitalization. This has been done based on the research summary of earlier scientific publications in the field of Change Management and application of value-benefits analysis interviewing middle and top levels of management in major enterprises. As a result, it can be summarized, that (1) measurement strategy is a ‘cornerstone’ of successful corporate communication; (2) measurement efficiency is only possible, if it is supported by a digital system providing the key qualitative characteristics of information: relevance, reliability, comparability and understandability. Further research approaches could be focused on the measurement of inter-human communications.
CONCENTRATION DYNAMICS IN THE MARKET FOR AUDIT OF PUBLIC INTEREST ENTITIES IN LATVIA

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Keywords: Audit market, Concentration, Audit firms, Public-interest entities

The study of the market for audit of public interest entities (PIEs) has become increasingly relevant in the aftermath of the EU audit reform. The aim of this paper is to examine the dynamics of concentration levels in the market for audit of public interest entities in Latvia from 2016 to 2018. This is important to identify the initial effects and the likely consequences of the new EU statutory audit legislation (i.e. Directive 2014/56/EU and Regulation 537/2014) that entered into force in June 2016.

The objectives of this paper are to analyse annual reports of Latvian PIE audit firms and their associates and compute some key measures describing concentration – the Herfindahl-Hirschman index and concentration ratios CR₁ or CR₄. It also analyses market concentration in different categories of PIEs, notably banks.

The methodology of the paper includes systematic, logical and comparative analysis, analysis of statistical data, as well as expert method.

The main findings are that the concentration of the market for Latvia's PIE audit firms/networks remained relatively high after the EU audit reforms. Furthermore, the Big Four firms' effectively have an oligopoly in the PIE audit market and one of the Big Four firms is dominant in the banking sector. The authors develop recommendations aimed to make the Latvian audit market more transparent and less concentrated.

References


THE MANAGERIAL PROBLEMS OF RUSSIAN TECHNOLOGY STARTUPS

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Keywords: technology startup, governance, management, technology entrepreneurship, business model

In the article the importance of small business and technology startups as the main sources of GDP and innovative development is studied by the developed economies examples. The results of the Russian technology startups research conducted by Bauman Moscow State Technical University are considered.

Research hypothesis: the survival of technology startups depends on the management quality and on the business model choice in the early stages of enterprise life cycle. Research aim is to identify the main management problems in technology startups in the early stages of the enterprise life cycle. The objective is to develop a structural and logical model for technology startup management system study; to identify the Russian technology startup and its founders profile; to identify business models used in the early stages of company development; to find out main managerial problems of technology startups in the development and growth stages. In order to form a database of research and total population sampling the following bases were used: Generation S, Russian Venture Company, RBC, Skolkovo, TechUp, Rusbase, Engineering entrepreneurs club of Bauman Moscow State Technical University. In this case incomplete enumeration and mixed sampling were used. A survey of 81 technology startups founders and managers was conducted (more than 400 research invitations were sent). During the meetings of Engineering entrepreneurs club of Bauman Moscow State Technical University 25 in-depth interviews with the startups founders and leaders were collected. For the study two questionnaires consisting of 44 and 75 questions were developed in electronic form. The study revealed the main problems of management and development through self-assessment of the level of management environment and in-depth interviews. The majority of problems are connected with the manufacturing process management and wrong choice of business model. The main factors of startup survival rate were defined. A method for startup management environment assessment and improvement was developed. This method allows the management of small industrial enterprises to diagnose the management environment in the company, to identify bottlenecks in management, and to take measures to prevent managerial problems. The method may be recommended to investment funds and development institutions in deciding whether to support the company.
IMPACT OF THE HUMAN CAPITAL FACTORS ON THE COUNTRY COMPETITIVENESS

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Keywords: competitiveness, human capital, impacts, human capital development, factors

The issues of competitiveness are in the centre of attention of the economists all over the world. Many researchers devote their studies to this problem. Nevertheless, the changeability of the world and all processes open the field of activities and new directions of research.

The importance of human capital for the country competitiveness is unambiguous. However, the concept of human capital is under development, and new factors of its development are discovered. Therefore, it is natural, one index, even if it is generated from many sub-indices and consists of many indicators, cannot comprise all aspects of the concept and stay unchanged for decades.

The goal of the research is to determine the impact of factors of human capital on the level of the country competitiveness, and the degree of their impact.

The traditional methods of the research have been used for this purpose: analysis, classification, grouping, multi-factor regression analysis.

The regression analysis has shown that some of considered factors have strong influence on the level of the country competitiveness, expressed via Global Competitiveness Index values. These factors are as follows: export of high-tech goods, working population with higher education among the able-bodied population, household final consumption expenditures, young people who do not study or work and not searching for education or work. Quite expectedly, the first three variables have positive betas, while the last one – the negative one. This fact is logically explained from the point of view of economics. Some factors have not shown the significance for the independent variable, though they are important for the human capital development. The quality of the model is high and therefore, it can be concluded, that these factors of human capital development (export of high-tech goods, working population with higher education among the able-bodied population, household final consumption expenditures, young people who do not study or work and not searching for education or work) have strong impact on the country competitiveness, though they are not included into Global Competitiveness Index. It means, they must be considered by the country government in the process of advancing the country competitive position in the world.
RESEARCH OF THE CLIENTS’ SATISFACTION AND LOYALTY IN HOSPITALITY BUSINESS

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Keywords: client’s satisfaction, loyalty, hospitality business, assessing the level of satisfaction

The provision and maintenance of the client’s satisfaction in the hospitality business is one of the main directions for effective development and maintaining competitiveness of it(Sharma,2016). It is becoming relevant to study, on a permanent basis and monitor potential consumers’ preferences in order to find groups of factors that influence the formation of loyalty among consumers of hospitality services. Provision of clients’ satisfaction has become the philosophy of the hospitality business, it has a tendency to create the values for clients, surpassing and managing their expectations, demonstrating the ability and responsibility as far as the satisfaction of the client’s needs is concerned. In the long-term prospectus the loyalty may lead to the stable competitive advantage (Sunny & Ham, 2014). As Evans and Lindsay point out (Evans & Lindsay, 2010), in order to satisfy the needs of the client in services or surpass his/her expectations, the organisations shall be fully aware of the whole scope of service attributes which lead to the client’s loyalty.

The research on consumers’ satisfaction makes it possible to estimate the clients’ satisfaction in general, make a conclusion about the values of the clients, highlight the priorities, influencing the improvement and also raise customer retention rates. The problem is that there are no universal methods how to evaluate the clients’ satisfaction and loyalty. The choice depends on a lot of different factors: the specifics of the information an organisation is willing to receive, its budget and also the opportunity to realize the research; experience and researchers’ preferences, etc.

In the given paper the authors consider the existing methods which were applied in order to estimate customers’ satisfaction, giving analysis of the advantages and drawbacks of these methods. The results of the research presented were received based on the research of J.J. Lambin (1993). The analysis of the influence that certain aspects of the hotel and its guests interaction have on the feeling of satisfaction with the service a hotel provides and loyalty in the sphere of hospitality, in general. The practicality of the method is proved and the ability to use this method in the hospitality industry. The results obtained may be useful not only for hospitality business in general, but could be applied in the current activity of the manager for monitoring the process and timely correction of the ‘problem’ zones in the communication with the clients.

References

Education and Training in Engineering
EVALUATING UNIVERSITY RESEARCH PERFORMANCE: WHAT CRITERIA TO USE?

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Keywords: university management, research quality, assessment indicators

Evaluation of the university performance is one of the most important issues the university management is concerned with. Higher education institutions make use of various indicators to assess their performance, the assessment indicators being grouped into different areas, for example, teaching, academic staff, educational services and facilities, research and innovation, etc.

In the competition to attract research funding for increasing their reputation as research-intensive institutions, modern universities pay a great deal of attention to measuring research outcome. Managers responsible for the research quality have to understand what can drive research excellence at their institution; this is vital for developing appropriate research strategies. A regular evaluation of research quality against international standards of excellence will help the university management to make decisions necessary for allocating research funding on the basis of the obtained results. In the process, different research quality-evaluation methods can be applied; the process itself can be formalized through Research Assessment Exercises (RAEs) that are used for assessing research in the international context, in terms of the standards prevailing at the global level. Research Assessment Exercises are intended to inspire world-class research and stimulate research excellence in contemporary academia and research institutions.

This paper examines the results of the Research Assessment Exercise undertaken for the Ministry of Education of the Republic of Latvia in 2013. The assessment was aimed at producing analytical material that would provide evidence for science policy making at different levels, and enable the institutions involved in the process to improve their research performance (Arnold & Knee, 2013).

To achieve the above aim the following objectives were set by the author:
1. To examine the methodology applied by the international expert panels involved in the Research Assessment Exercise for measuring research output of a higher education institution.
2. To describe the assessment indicators used by peer reviewers in the evaluation process.

The following research methods were used by the author:
1. Review of theoretical literature related to the assessment of research performance.
2. Review of previous research on the topic.
3. Analysis of the reports prepared by the expert panels.

References
THE RELEVANCE OF MOBILE AND DISTANCE EDUCATION; DEVELOPING AND ADVANCED APPROACH TO LEARNING

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Keywords: Distance Learning, M-learning, Digital Influence, Learning Platforms, Learning Methodology

In recent years’ education has transformed from its traditional arrangements to blending education, where traditional learning meets technologies. Learners recommend on what type of educational styles they prefer. They expect the incorporation of mobile technologies into educational learning. That’s where distance and M-learning come into play.

Nowadays, higher educational institutions are challenged to innovate and give new educational opportunities. Distance learning has been on the scene for several years. It provides an amazing opportunity that allows teacher-student communication without a specific location to study. It enables interactions via digital platforms where learning information is exchanged. However, not many countries allow distance learning.

M-learning has emerged as an innovative approach to learning where it allows learning to be taken directly to the people, countries, and communities. M-learning connects and links people virtually in various countries where education was not available. Today, with the help of mobile technologies, learning can be affordable and achievable by many.

These days we live in a mobile era where people daily buy and use new mobile technologies. Educational institutions in higher education need to promote those new trends as it will aid learners to be more technologically competent to modern challenges. Educational platforms, applications, and systems have to be mobile friendly.

A new type of learning has a huge impact on education and society as there are learners who want to study outside the classroom on their own time. Some of them need it for career development, practical experience, knowledge enhancement, etc. This integration has to be on a national and international level.

Distance and M-learning could be self-paced and time-bound. It allows learners to plan so it suits their lifestyles. For the institutions, it is a handy approach. It allows them to reach students around the world. It is interactive and instant learning process assisting to acquire skills, habits, and knowledge. It facilitates the fast-paced learning process.

Distance and M-learning are highly popular with youth and adult learners. However, why are there so many countries that do not support this type of education? I believe in many countries, and especially in developing countries educational systems still believe in traditional, on-site education. They do not see the benefits. They are not comfortable to accept the change.

The purpose of the study is identifying how relevant is distance and M-learning to the modern, digital society. It is a time of technologies where educational advancements have to be accepted on a national and international level. The study will look into details of distance and M-learning, analysing advantages and disadvantages. The study will look into the reasons why some countries do and do not accept this type of learning. They study will make a comparison and observational analysis of Georgia and the rest of the world. The study will analyse information obtained from education professionals in Georgia about distance and M-learning. The result of the study will create awareness and promote distance and M-learning, especially in Georgia.
THE ROLE OF INNOVATIVE METHODS IN TEACHING ENTREPRENEURSHIP IN HIGHER EDUCATION: MULTIDISCIPLINARY APPROACH

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Keywords: Entrepreneurial mindset, Students’ business ideas, Entrepreneurship, Innovative methods, Digital automatic tool

Nowadays increase of income and social security of employees determines decreasing percentage of those young people finding entrepreneurship an attractive occupation for earning income and economic stability. In Latvia and other European countries, especially in old EU member countries, institutions of higher education are facing challenges in teaching entrepreneurship using innovative, practical methods of learning, including automatic tools for verification of business idea viability.

The aim of the research is to find out innovative and multidisciplinary approaches for education in entrepreneurship, including the usage of digital automatic tools for checking and improving of students’ business ideas.

The objectives of the research are to analyse theoretical aspects of the role of entrepreneurs in society, to analyse latest statistical data on societal values regarding entrepreneurship and newly established businesses, and to assess the results of survey conducted among students in selected European countries to assess the perspective of usage of authors’ developed digital automatic system.

Feldman & Bolino (2000) as well as Katz (1994) believe that the intention to become an entrepreneur depends on the person’s will. Drucker (2002), Gupta, (2012) describe successful entrepreneurs as would-be innovators. Lefebvre (2017), Barosso (2017) conducted several studies dealing with business survival and development issues. Nowadays innovative and multidisciplinary approach to teaching entrepreneurship includes the use of automatic digital systems for assessment of business ideas (Mori et al., 2016; Awad and Khanna, 2015). Digitalization provides more opportunities to use automatic education tools and artificial intelligence solutions that could be scalable and thus widely applied, especially in distance learning.

The research is based on existing researches and comparative analysis of business activity, analysis of statistical data and survey made by authors. It also includes identifying and discussing innovative teaching methods, especially digital automatic tools, in entrepreneurship.
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CONDITIONS FOR FOREIGN STUDENTS' ADAPTATION AND ITS FEATURES IN THE HIGHER EDUCATION INSTITUTION IN LATVIA

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Keywords: students' adaptation, higher education institutions, internacialization of education, foreign students

Internacialization of education and students’ mobility have been in the focus of attention of the educational community in recent years. These issues are closely connected with cultural and intellectual exchange, human resources development and to a great extent, concern the quality of education, communication, etc. (Knight, 2007; Altbach and Knight, 2007). Availability and composition of foreign students are becoming one of the principal indices of the Institute’s rating in the international educational area. One of the requirements for Higher Education Institutions nowadays is to create all necessary conditions for students’ adaptation to the conditions provided by the Institute and to the study programmes (Standards and Guidelines for Quality Assurance in the European Higher Education Area, 2015). Adaptation of foreign students constitutes part of the social responsibility of the Institute, directed at provision of the students’ international equality.

In order to maximize advantages for both foreign students and the Institute-recipient, it is important to define the existing problems that an Institute faces and offer possible ways how to solve them. Even under the most favourable conditions the adaptation to the new sociocommunicative environment, getting acquainted with new culture, traditions, coming across local peculiarities in different spheres of life give rise to a number of problems, inconveniences, etc. While staying in a foreign country, it inevitably takes more or less time to get adapted not only to living conditions but also to adapt to the new educational environment and study programs and also to the requirements and even the manner of delivering lectures, conducting tutorials by the teaching staff. An important condition of success in studies for any student and for successful integration into the educational environment is mastering the language of tuition – English, Latvian or Russian.

The aim of the given research is to study the peculiarities of the adaptation process of foreign students who came to Latvia from Kazakhstan, Uzbekistan, India, Pakistan, Russia and other countries.

The research was conducted by the teaching staff of the Chair of Humanities in the Institute of Transport and Communication. The following empirical methods have been used: foreign student survey for the last three years and talks with lecturers and tutors conducting classes and delivering lectures in such study groups the processing methods were descriptive statistics. Based on the results, the authors offer recommendations aimed at intensification of work with foreign students at the initial stage of training. Knowledge of the difficulties of foreign students’ adaptation will help to build the work with them more correctly, to supervise the learning process more effectively, starting from the first days of their stay at a university.

References


INVOLVEMENT OF ADULT FEMALE STUDENTS IN DISTANCE LEARNING AS AN OPTION TO OVERCOME THE LEARNING BARRIERS

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Keywords: adult female students, learning barriers, distance learning

The increase in the number of adult students is one of the main trends observed in the world education area. Latvia education development strategy also envisages an increase in the proportion of adult students. Although there is gender asymmetry among adult students, an increasing number of women are entering the labour market and simultaneously trying to continue their education, including higher education. Many researches have been devoted to the barriers to participation in adult education and training. However, admission to the university does not remove the problems associated with these barriers.

The aim of the study conducted by the authors is to identify and to study the difficulties faced by adult female students. A target sample of 20 adult female students has been selected for the research. The main method of the research is interviewing, as well as the analysis of the conditions offered to non-traditional students by some universities in Latvia.

Lack of time and energy has been identified by adult female students as the main problem, which they face. The reason is the family and household load and the need to perform numerous roles and an attempt to balance them with the role of the student. Next group of barriers is insufficient family and social support. Especially young women having little children feel the lack of understanding and support from their partners. Female students, belonging to the older age group, are better supported by family members. As for this, Female students of different ages to the same extent named the lack of support from the employer as one of the main barriers. Furthermore, only some of the universities in Latvia, having the paid training programmes, are ready to give discounts on payment to students who have a certain work experience at the beginning of their studies. Another group of barriers is associated with higher level of anxiety and concern about the learning process and outcomes. The adult female students have a higher focus on achievements than their male peers, but they demonstrate less confidence in themselves, are afraid to show their incompetence, especially in technical issues.

The presence of these unsolved problems leads to the situation when non-traditional female students have a higher risk of dropping out before graduation than the traditional female students. To a certain extent, distance learning is the best way to overcome the barriers to adult participation in the learning process; the specific features of distance learning help employed female adults to study at the university. Nevertheless, even distance learning should ensure the creation of an educational environment that takes into account the needs and capabilities of the student and provide the most flexible approach from the academic and support services to adult students in general, and especially to female students. For example, lecturers and tutors can help students to achieve their educational goals by developing a curriculum with flexible deadlines and expectations. They can also combine tasks that meet the needs of adult female students and relate to their life experiences. It may be advisable to provide initially the adult students with professional psychologist’s support. The special training of staff and lecturers, working with non-traditional students, will be useful.

Considering the forecasted growth of number of adult students such measures will create good conditions for offering the higher education of high quality to these student, and possibility for universities to remain competitive.
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