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**(RelStat'16)**

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**ABSTRACTS**

Edited by

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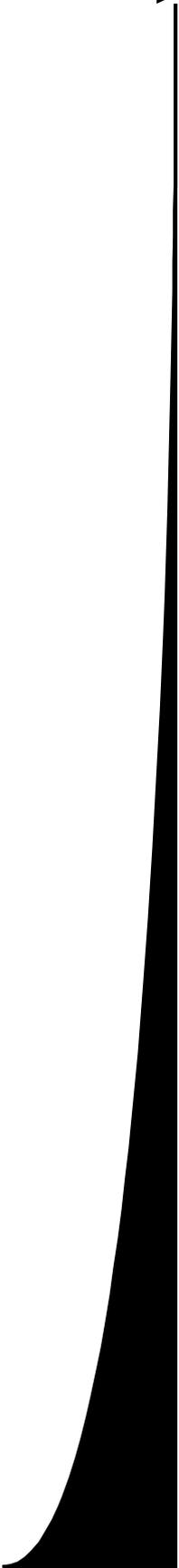
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# Plenary Session



## **METHODOLOGY TO ASSESS THE EFFECTS OF ICT-MEASURES ON EMISSIONS. THE CASE STUDY OF MADRID**

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**Keywords:** GHG emissions, ICT-measures, Floating Car Data, traffic simulation, emission simulation.

The road transportation sector is one of the largest emitters of Greenhouse Gases, which triggered the climate change. Much effort is dedicated to reduce the emissions, highlighting the use of Information and Communication Technologies. In this framework, the ICT-Emissions project has developed the methodology necessary to estimate the effects of ICT-measures on emissions. Based on this methodology, this paper presents the results of the measures tested in the case study of Madrid: Section Speed Control, Variable Speed Limits, Cruise Control, Eco-Driving and Green Navigation. Some of the measures have been analysed with real Floating Car Data, comparing the fuel consumption before and after implementing the ICT-measures. On the other hand, Green Navigation results are based only in simulation. Although the level of analysis is different for each of the tested measures, the results show positive values in terms of CO<sub>2</sub> emission reductions and prove the applicability of the ICT-Emissions methodology.

## BLUE CARE: A COOPERATIVE LOCATION NETWORK FOR HANDICAPPED PERSONS

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**Keywords:** Cooperative location networks, behavior analysis, mapping, safety, security

Improving citizens' mobility in terms of their safety and security is one of the major concerns of cities all over the world. Half of the world population is concentrated in cities and by 2050 two thirds of world's people are expected to live in cities. This trend will increase the challenge (Cancedda *et al.*, 2013). Many citizens get lost or missing in cities, especially the handicapped persons, but as dependents, they often lack the skills to protect themselves. The children, the elderly and disabled people (handicapped persons in general) are the focus of this work. Knowing the dependents' location is the key to knowing that they are safe (Steiniger, *et al.*, 2006). However, carers cannot keep their dependents in their sights all of the time. Therefore, the challenge to be tackled in this work is to develop a cloud service over which carers could monitor the dependents' positions in real time, giving them more freedom to safely roam within the public spaces. Not only in open spaces such as crowded parks or streets, but also inside buildings such as city malls, museums or nursing homes.

Currently, the market offers four kinds of solutions for positioning the dependent. The first one uses a hose-clip or a wrist-worn that integrates a GNSS (Global Navigation Satellite Service) receiver to determine the geolocation of the dependent, and a modem to send the geolocation data to the carers via cellular networks. However, it has a high cost, around 100 €, it needs an extra monthly fee due to the cellular data communication, and it does not work indoors (FiLIP, 2016) (Tinitell, 2016). The second one tracks the smartphone of the dependent using their sensors. However, it can only be used for those that routinely carry a smartphone, uncommon for the dependents' profile, and its availability indoors is limited (Situm, 2016) (Proximus, 2016). The third one uses a low-cost and battery free NFC (Near Field Communication) bracelet, such as the passive RFID (Radio Frequency Identification) technology, that is carried by the dependent and whose position is updated every time the dependent's bracelet is detected by a NFC reader. However, its range is limited to a few centimeters which means that it would be needed a big amount of NFC readers to track the dependents (Appkideak, 2016). The last one is technology free and thus the cheapest one. It uses a bracelet where the main profile characteristics of the dependent have been written down. However, it cannot track the dependent and the bracelet has to be identified visually (Silincode, 2016).

The solution proposed in this work uses a bracelet carried by the dependent. It integrates a low-cost BLE (Bluetooth Low Energy) transceiver which regularly broadcast a unique identifier (ID) at constant power. Its range depends on the transmission power, but it usually ranges from 20 to 50 meters. The dependent bracelet's position is determined within the range of a carer BLE transceiver, while the position of the carer is assumed to be previously known -if its BLE device is fixed- or estimated by a location engine (Bahillo, *et al.*, 2016) -if its BLE device is dynamic-. The target users who will benefit from this solution are the dependents living in a medium or large city where security and mobility issues are evident; and the carers who will monitor for their safety. The customers will be the public administrations and nursing homes who looks for giving the dependent more freedom to safely roam within the public

spaces, reducing the costs in security; the malls and commercial stores who look for improving their services' offer and advertisement; and the museums who look for knowing which area features are most visited and what not.

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Tutorial



# RFID IN LOGISTICS AND PRODUCTION – APPLICATIONS, RESEARCH AND VISIONS FOR SMART LOGISTICS ZONES

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**Keywords:** Auto-ID, RFID, Industrie 4.0, Automotive, Retail, Smart Logistics Zone

ID Numbers on each object are the basis for *Industrie 4.0* projects.

The demands on the automatic identification and localization as also the condition monitoring of logistics objects as sources of data for a secure supply chain's documentation and control are increasing. Significant synergies for safety and security tasks in logistics can be obtained by combining the use of radio and image identification and positioning technologies to automatically determine the status of logistics processes by motion and state analyses. ICTs are entering infrastructures (esp. logistical nodes) as well as becoming essential to equipment, freight and operative staff to ensure that necessary information such as the location and status of shipments is available even at the logistical boundaries.

Smart Logistics Zones are understood as the sphere of action of mobile objects in logistics infrastructures equipped with ICTs which form an ambient intelligence. Smart Logistics Zones define a multiple use concept for the technical systems for identification, localization and condition monitoring in logistics. Furthermore a spatial reference needs to be integrated into the definition, as logistics processes are defined by moving and handling objects along space and time. By that, several spatial and object levels have to be taken into account along typical supply chains: Individuals (staff), single objects (goods/freight), mobile resources and infrastructures. The integration of the technical systems along those spatial and object levels in supply chains marks a central challenge to establish Smart Logistics Zones.

A Smart Standardized Logistics Zone is established individually in any supply chain and constitutes the target area in which information must be acquired in the particular logistics systems and processed. A key challenge of information logistics is the necessity for compatible and interfaced execution of the numerous subsystems, from sensor sources to performance measurement functions, which exist on the individual levels of a logistics zones in parallel and partly in competition.

Radio Frequency Identification (RFID) is expected to improve Track & Trace approaches in the supply chain. The automotive industry is considered to be one of the pioneers in RFID application. In spite of the recognized RFID potential in the automotive industry, relatively few cross-company RFID applications have been put into practice so far. Two of the principal challenges in RFID implementation that have been identified are:

- Dealing with the physical constraints of RFID technology such as metal reflections and shielding effects,
- integrating RFID into existing IT infrastructures due to missing standards such as mandatory data structures and appropriate IT backend communication.

RFID solutions for Tracking & Tracing parts and components within the automotive development process are particularly challenging due to the fact that the parts are assembled to vehicles. The vehicle body acts as a Faraday cage and shields the assembled parts. Moreover, automotive parts vary in shape and material, and therefore require different types of RFID transponders to be applied. The exact position and orientation of the prototype parts also vary and depend on the specific vehicle types the parts are assembled to. Therefore, variance and variability contribute to project complexity.

Continuous tracking of products and automated management of empty pallets are steadily growing in importance in the retail industry. This paper describes in the second part the steps required to effectively roll out RFID-tagged plastic pallets – from the selection and integration of RFID transponders to the manufacture of pallets and even their management.

The Fraunhofer IFF supported these RFID projects for an automotive manufacturer and for a pallet manufacturer in the retail sector as part of Industrie 4.0 activities.





## Session 1

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# **Reliability and Risk Management**

## FACTORS OF EMERGENCY SITUATIONS RISKS MANAGEMENT IN THE BSR PORTS

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**Keywords:** risk analysis, planning, port, transport infrastructure

The transport infrastructure most obviously affects the movement of goods internationally. Port is one of the most significant transport infrastructure elements through which are facilitated transportation, communication, and business exchanges. Another issue at ports is the effectivity of their connections to the remainder of the country's transport infrastructure, such as rail and road. It is essential to better understand and apply risk analysis in the ports and assessment methods in mitigating accident risks and areas adjacent to these.

Risk analysis in ports is important for ensuring reliability, supply chain resilience, and transport safety and security in logistics operations.

Risk assessments are very important to both logistics operators and Rescue Services and other Civil Protection, such as Customs, Border Guard, Coast Guard and Police and environmental agencies. Effective transportation and the transportation safety risk management in transport hubs can increase interoperability in transporting goods and persons in North–South and East–West connections based on increased capacity of transport and logistics actors.

For these reasons there is necessity in Baltic Sea Region transport hubs (port and hinterland infrastructure) to improve interoperability of resources in case of emergencies and develop a model for a complex analysis of all involved actors resource management in emergency situations. A model must be developed using the comprehensive quantitative and conceptual description of the transport hub:

- multivariant design of the logistic operators and separate port safety and security subdivisions management in emergency situations;
- multiple criteria analysis of the separate actors activities management in emergency situations;
- selection of the most rational version of the unanimous port and hinterland divisions recourse management in emergency situations;
- optimization accident consequences and mitigation of threats and environment degradation.

The effective all transport hub actors activities management will support multimodal transport safety issues including protection from emergencies and accidents (including hazardous substances) associated with transport to reduce risk to human life and environment.

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## EVALUATION OF STOCK MANAGEMENT STRATEGIES RELIABILITY AT DEPENDENT DEMAND

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**Keywords:** supply chains reliability, stock management, dependent demand, perfect order

For efficiency increasing the logistic systems, the core specialists' attention has to be directed to reducing costs and increasing supply chains reliability. A decent attention to costs reduction has already been paid, so it can be stated that in this way there is a significant progress. But the problem of reliability evaluation is still insufficiently explored, particularly, in such an important sphere as inventory management in dependent demand.

The publications analysis has allowed to reveal the opinions of several authors about features of stocks management in dependent demand. “Dependent demand” means the demand for one item is related to the demand for another item. The dependent technique used in a production environment is called material requirements planning (MRP) (Heizer and Render, 2011). Originally popularized by Joseph Orlicky, MRP deals specifically with supplying materials and component parts whose demand depends upon the demand for a specific end product (Coyle *et al.*, 2003). The purpose of MRP is to avoid carrying items in inventory (Ballou, 1999).

Effective use of dependent inventory models requires that the operations manager know what is to be made and when; materials and parts required to make the product; what is in stock; what is on order; how long it takes to get various components (Heizer and Render, 2011).

Protection against uncertainty in the requirements and supplies that are part of material requirements planning can be achieved with the aid of safety stock and safety time (Jonsson, 2008). It seems wise to include “some” safety time into the lead-time offset of uncritical operations that is the direct predecessor of a critical operation (Stadtler and Kilger, 2008).

The minimum projected on-hand inventory should not fall below the safety stock level (Wisner *et al.*, 2012). The safety stock is also a planning parameter that can be chosen arbitrarily (Axsäter, 2006). A fixed on hand-inventory level can be maintained that is determined by practical experience or some other means. Although this method is approximate, it is probably the best that can be done (Ballou, 1999).

The usual policy is to use safety stock for end items and purchased items to protect against fluctuating customer orders and unreliable suppliers of components but to avoid using it as much as possible for intermediate items (Krajewski *et al.*, 2013). If the firm does not exceed 99 % record accuracy, then material requirements planning will not work (Heizer and Render, 2011).

Thus, in spite of having several strategies (lot-for-lot – LFL; least total cost – LTC; least unit cost – LUC; part-period balancing – PPB, Silver-Meal algorithm, Groff's method etc.) for dependent demand management, all of them are intended to the calculate the current stock parameters. Other indexes, for example, probabilistic evaluation of insurance stock, deficit, functioning reliability of all stock management system practically are not considered. This problem becomes even more vexed at supplying the component parts (items, details etc.) that cannot be made at this enterprise.

Generalization and analysis of different approaches have allowed us to hypothesize that for the evaluation of component elements insurance stock a perfect (or ideal) order concept should be used. It is obvious that in the first approaching to the evaluation of reliable supplied

consignment we may be limited with several indexes: the quantity (percentage of orders supplied at full volume), the quality (shipped products without damages or defects), and also the timeliness (just in time) of supply.

For the reliability calculation on the basis of the insurance stock account in dependent demand, the algorithm which includes following steps has been developed.

1. Defining the nomenclature component elements groups in account of the lead time (day, week, month etc.).
2. Collection, analysis and statistical processing of data of failures at supplying with component items.
3. Defining the probabilistic reliable characteristics on each of analyzing perfect order indexes.
4. The empiric data approximation with the corresponding distribution laws (binomial, Poisson and other).
5. The choice of the alternative calculation variants (taking into account the time of additional supply of insurance stock besides basic consignment).
6. The calculation of the optimal size of insurance stock for different strategies taking into account reliability and logistic costs (order, transporting, storage and other).

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## MODELS AND ALGORITHMS FOR ESTIMATION AND MINIMIZATION OF THE RISKS ASSOCIATED WITH DREDGING

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**Keywords:** dredging, risk situations, transport, Maple

Dredging is a kind of underwater operations produced at the bottom of the water body in order to create new waterways or deepen the existing ones, construct piers, bridges and other hydraulic and water facilities, as well as to expand and increase the depth of the water bodies. Dredging is divided into capital and operating types. Capital dredging is performed to improve the quality of navigational conditions, as well as in the construction of hydraulic structures. Maintenance dredging is performed to clean water facilities. Dredging is the primary method of ensuring the specified size of ships' ways and improving shipping canals. Dredging operations are carried out by means of dredgers, which extract and remove from the riverbed grounds difficult for navigation. Dredging is inherently complex technical process that depends on many factors. Dredging involves large technological, economic and environmental risks. The process of assessing the risks described in this paper is a tool intended to help to identify hazards and to formulate the problem, so that reduce the risk to an acceptable level of risk. Risk assessment consists of a frequency analysis, impact analysis, and their combination. The main objectives of the risk assessment stage are interconnected and include the following ones: determination of the frequency of occurrence of initiating and all unwanted events; assessment of the impact of adverse events; compilation of risk assessments.

In generalizing risk assessments, it is recommended to analyze uncertainty and accuracy of the results. In most cases, a source of uncertainty in the case of dredging will be incomplete data on production technology, reliability and precise operation of the equipment as well as human errors. In order to interpret the results of the risk assessment properly, it is recommended to understand the nature of the uncertainties and their causes. Sources of uncertainty are recommended to be identified and evaluated and results to be presented. The authors carried out a qualitative and quantitative risk assessment. Qualitative risk analysis reveals the sources and causes of risk, stages and work in the course of which a risk may arise (finding potential risk areas, identifying activities associated with risks, finding practical benefits and negative effects of identified risks). Quantitative analysis provides numerical values of both individual risks and for the entire facility. It is also possible to calculate the potential damage and to develop a system of preventive measures aimed at minimizing the occurrence of risk situations. In the risk analysis, risk matrix and generic risk assessment algorithm were used.

There are a lot of models and algorithms to minimize risks during dredging operations and they are not without drawbacks. The paper deals with the author's approach to solving this problem. Mathematical models are proposed and, on their basis, soft ware is developed. Methods of the risk theory are used to minimize the risks. Risk is "a consequence of the impact of uncertainty on the achievement of goals." "A consequence of influence" in the paper refers to the deviation from the goal, expressed in the expected results and the deviation of certain

criteria indicators. In this case, we mean any measure of quality (soil amount, width / depth of the dredged path in a given area). In its turn, risk factors reduce criteria indicators. These factors are divided into categories: general transportation risks and risks of transporting ground. In these categories, one may derive the following risks: incident sat transport resulting from the impact of a set of random factors, including the human one. The simultaneous occurrence of all risk situations is unlikely. Furthermore, it should be noted that the occurrence of a risk situation could determine and have a direct impact on the other. As a result, you may experience a chain of risks connected to each other. Evaluation of the situation that may entail the maximum possible loss of the criteria indicator among all the risks in the proposed model is offered by constructing an acyclic directed graph of risk situations.

For risk analysis and management, in addition to identifying critical chains of risk situations, a stochastic model for evaluating the chains is set forth. With taking into account the large number of empirically evaluated risk situations, the dimension of the adjacency matrix of this graph allows you to apply the exhaustive search algorithm.

In order to implement this algorithm, mathematical package Maple is used, where it becomes possible to carry out the required calculations with a software package including GraphTheory. The paper presents fragments of the code listing.

## RISK MANAGEMENT IN IMPLEMENTING WIND ENERGY PROJECT

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**Keywords:** risk management, wind energy project, SWOT analysis, McKinsey matrix, project risks

Analysis of possible risks in the process of implementing a specific project has been carried out, measures to reduce their negative impact on the project have been developed and proposed. The object of study is a wind energy project, namely a wind farm working as part of the national energy system. The implementation of the project is related to both external and internal risk factors that are characteristic to such projects in the real economy sector under the current conditions. Such risks have been classified and the fractional structure of risk adjustment has been analysed taking into account the properties of the particular wind energy project, which consists of three main components (Rolik, 2008). It has been noted that the most significant contributor to the project risks is the component consisting of technical, technological and commercial risks. It has been established that in order to limit the negative influence of technical and technological risks, when selecting the manufacturer and equipment type for a particular project, priority should be given to innovative technology that holds a beneficial advantage over the competitors (Rolik and Gornostay, 2015). A description has been given of the innovative technology selected for project implementation, power generation using wind (Siemens, 2013), which is used to limit the negative influence of the above-mentioned risks.

The current strategic management tools, such as SWOT analysis (Shinno *et al.*, 2006) and McKinsey matrix (Rasiel, 1999), which are useful for the identification of project risks, have been examined (Rolik, 2015). It has been proposed to carry out the viability and financial feasibility evaluation of the envisioned wind energy projects with joint consideration of the internal and external environment (SWOT analysis method). Furthermore, the basic data obtained as a result of the evaluation of the present project state using SWOT analysis were summarised. It was established that the number of strengths of the project exceeds the number of weaknesses (6 against 3). It was also established that many potential threats arising from the confirmed weaknesses are caused by the novelty of the project and would be eliminated after the implementation of the second stage of the chosen strategy.

The data obtained as a result of the analysis serve as a basis for the evaluation of the project development possibilities, while taking into account the level of expected threats in its further promotion. With this aim, the traditional matrix was filled. Each of its four filled squares contained information, based on which it will be possible to make decisions about the implementation of the wind energy projects.

At the same time, it has been proposed to evaluate the internal and external aspects of the wind energy project using the McKinsey expert matrix (Rasiel and Friga, 2004), which should be used to calculate the attractiveness of the business area and the competitiveness of the project as average weighted values and their subsequent positioning in the matrix. For the wind energy project that is being implemented, the project dot location coordinates were determined in the McKinsey matrix on axes: Advantages against competitors and Market attractiveness. Also, a sector characterising the project development prospects was established to be subsequently used as a tool for risk identification (Rolik, 2015).

It has been proposed that in the risk evaluation process the project should be evaluated according to a single scenario of its implementation. Moreover, the main consideration of

factors (i.e., the probability of circumstances arising that would undermine the project results) is carried out by including the risk adjustment norm in the selection (Yelistratov *et al.*, 2010). The risks of any wind energy project are classified as follows: project risks, market risks and managerial risks. It has to be noted that, from the aspect of reduction of negative influence, managerial risks formed through legal relations between the project participants should be considered as the main risks. Their main types are: form of ownership, enterprise management, generation and use of own capital, control over the use of funds, the responsibility of the owners, shareholders' general assembly, succession, dissolution of relationships, and validity and substitutability of participation.

Following the identification of risks, specific measures of state support and special project management measures were developed and proposed to be implemented with the aim of limiting the negative influence of the possible project risks. Meanwhile, the main project management measure should be to ensure operational control and the timely troubleshooting of problems (Rolik, 2004) arising in the working process to improve the uptime and substantially reduce the downtime of equipment (Rolik and Gornostay, 2010).

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## ON SENSITIVITY ANALYSIS OF AGING MULTI-STATE SYSTEM

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**Keywords:** Multi-state system, Sensitivity measures, Availability, LZ-transform

The presentation considers a sensitivity evaluation for an aging multi-state system (MSS) under minimal repair. Investigation of an impact of changing different failure/repair rates of different elements in MSS is important for practical reliability engineering. In practical reliability engineering the large number of states that should be analysed for a multi-state system model is a main obstacle for the sensitivity assessment.

Straightforward Markov method, applied to solve this problem, requires building a model with numerous numbers of states and solving a corresponding system of differential equations.

In order to challenge this problem, this presentation proposes a new method based on an LZ-transform of the discrete-state continuous-time Markov process. New sensitivity, useful for aging MSS reliability analysis, was introduced. It was shown that the proposed method drastically reduces a computational burden. Numerical example is presented in order to illustrate the approach.





## Session 2

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# Transport

## COMPARISON AND EVALUATION OF FARE COLLECTION TECHNOLOGIES IN THE PUBLIC TRANSPORT

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**Keywords:** Fare collection system; public transport; multi criteria evaluation of variants; integrated public transport systems

The development of electronic fare collection technologies records currently considerable progress in many types of payments, including the application in transport. Use of new technologies in public transport contributes both to higher customer satisfaction and smoother movement of passengers and also increases the efficiency of collection of fare compared to the current payment method. Currently are various market pressures to improve check in system based on paper ticket, whether in the form of a draft of new system or in potential measures to improve the current situation.

This paper deals with the fare collection technologies and ticketing in the public transport. There is an analysis of the present way of check in of passengers in the integrated public transport systems, including the modern trends in possibilities of check in of passengers. There are concepts of specific ways of comparison and evaluation of fare collection technologies with the utilization of the methods of multi criteria evaluation of variants. Individual proposed variants of check in are evaluated with emphasis on aspects their implementation in the integrated public transport systems.

## THE RESEARCH OF DRIVER DISTRACTION BY VISUAL SMOG ON SELECTED ROAD STRETCH IN SLOVAKIA

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**Keywords:** Visual smog, billboard, driver distraction, traffic accident

Driver distraction is one of the most common causes of traffic accidents in all countries. The previous research has shown that digital billboards can take the driver attention for more than one second. Therefore, the aim of the article is to research how visual smog can influence the driver behaviour. The road stretch in Žilina has been chosen for measuring the driver distraction by visual smog next to the road. The analysis of visual smog and traffic accidents on the selected road is included in article. Eye tracking glasses has been used to scan the gaze of driver eye. Part of the experiment was EEG device, used to record brainwave data during the testing of impact of visual smog to driver. The results regarding of driver gaze at visual smog are awful considering that the average dwell time of one billboard was more than a half second. On the other side, the average dwell time of traffic sign was only 0,2 second. In generally we can state that visual smog can influence the driver behaviour which can lead to traffic accident. For all that it is necessary to reduce the increased number of visual smog next to the road which can lead to fewer traffic accidents.

### Acknowledgements

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## ANALYSIS OF THE TRAM SAFETY: CASE STUDY OF ALGERIA

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**Keywords:** Tramway, Rail transport, Safety and Prevention, Quality and continuous improvement, Risk assessment

Transport represents one of the fundamental pillars of the sustainable development and the prosperity of any country. Effective transportation systems and modern networks are thus a need for economic development, the wellness social, the production on a large scale and the environmental protection. In Algeria, the transport sector knows a true change. A large number of projects were realized or are in phase of realization, in order to make this more powerful and more effective in its contribution in the economic development of the country.

Constantine as the big cities in Algeria profited from modern urban means of transport: the tramway, a line with double track a length of approximately 8 km comprising 10 stations, which aims at of improvement of the offer of public transport of the city (Fig.1). This line increases the accessibility to the users of the zones has direct influences at the zones served by the line.

The exploitation of these means of transport it is not a small mater, after three years of its starting, the tram of Constantine knew several difficulties in terms of integration in the live of citizen. In this context, this work aims to make an analysis of the actual safety situation in tramway of Constantine based on the already achieved operating period and even propose actions meeting the demands of this operating period. This system seen in advanced technologies and new features, put into operation for the first time in Algeria must be analyzed to justify that their safety level is sufficient opposite the severe risk acceptance criteria set by the national guidelines. The objective of this work has been to analyze accidents since its implementation already operating in 2013 and try to highlight the realities and prospects for railway safety in order to propose an action plan and recommendations for a safer transportation system. This work is a first safety analysis of a new guided mode of transport into service in Algeria which is the Tramway.

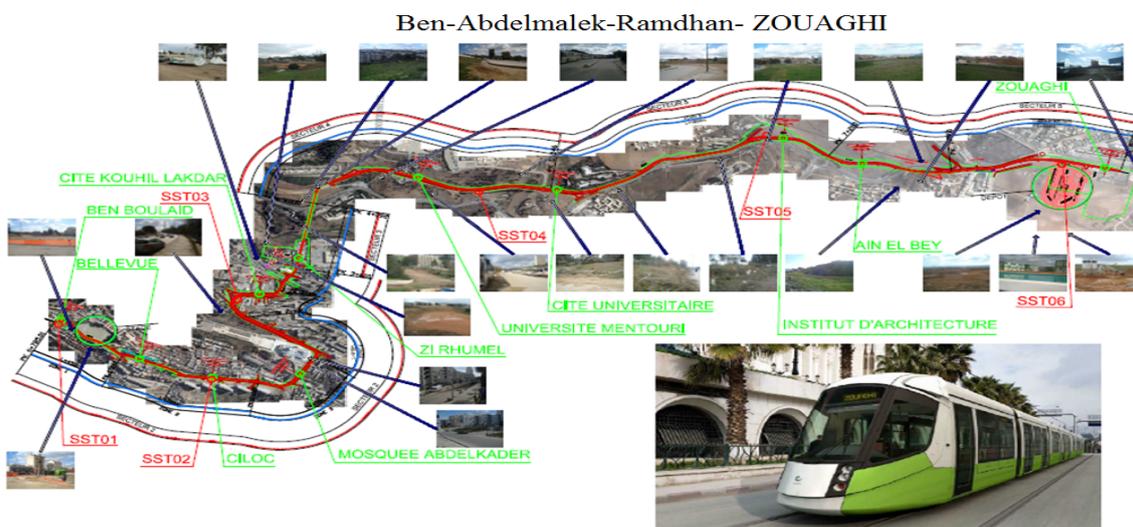


Figure 1. General view of the Constantine tramway line

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## **ABOUT FORMATION OF THE INTEGRATED REPORTING' PERFORMANCE IN THE PROCESS OF BUILDING A SUSTAINABLE BUSINESS OF TRANSPORT AND COMMUNICATION' COMPANIES**

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**Keywords:** integrated reporting, sustainable development, created value, capitals, stakeholders

Huge space and various Russian climate determine the importance of developing transportation and communication in the country. According to the Federal State Statistics Service of the Russian Federation on January 1, 2014 the number of these economy sectors' companies amounted to 178 214. Of these, 4.3% are commercial organizations that do not belong to small and medium-sized businesses. Corporate reporting is published in more large firms. According CorporateRegister.com Russian companies published 58 corporate reports in 2014. Of these, only two reports were published by mobile companies. Pursuant to the research (RRL, 2015) the transparency coefficient is 1.8 for the transport sector and 1.67 for the telecommunications on a scale of 1 to 5. This means that these sectors of the Russian economy remain nontransparent. The article explores the issues of providing business' information transparency and accountability by creating an integrated reporting and reflects its relationship to sustainable development of transport and communication enterprises.

The purpose of research is to build information blocks of an integrated reporting of transport and communication enterprises in order to increase their transparency, openness, and compliance of their reporting with the international requirements. The article presents the results of a study of the integrated reporting' concept in the context of building a sustainable business. These are founded on the approach according to which the action of the stakeholders must be based on the ideas of sustainable development, focused on the acceptance of the ideas of environmental and social responsibility. In turn, stakeholders give companies the resources that form its capital. The process of value creation accompanied by a capitals' value change caused by the organization's business activities and outputs. The result of this process is the value created for the organization and their stakeholders. The desire to maximize the value leads to an increase in competitive opportunities and advantages, and therefore contributes to long-term sustainable development of enterprises. Consequently, the inclusion of such key elements as "stakeholders", "capitals", "created value" in the basis of integrated reporting concept identifies it as a tool towards a building a sustainable business.

The article stresses that the development of applied nature of integrated reporting concept in the context of building a sustainable business is an essential element for its implementation in practice of formation of corporate reporting. Despite active discussion of the problems of valuation in scientific works, there are unresolved issues related to the ambiguity and variability of the methods of its computation. In this regard, the article suggests scheme for the construction of information blocks of an integrated reporting, synergistically linking three key approaches from perspectives of intrinsic value of a firm; value embodied in the capitals' value and changes therein; created value, which is influenced by the stakeholders.

To implement the second and third approaches the article proposes to use method of computation in form a single integrated indicator. It reflects the summarizing comprehensive assessment of impact of the studied factors on the created value.

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## ENSURING SUSTAINABILITY OF PUBLIC TRANSPORT SYSTEM THROUGH RATIONAL MANAGEMENT

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**Keywords:** public transport, sustainable development, decision support system, transportation model

Ensuring access to goods, working places, services, education and leisure facilities by means of eco-friendly, health promoting, socially and economically viable transport systems is a key factor to improve environment condition and quality of life as well as a factor of economic and social growth (Ambroziak *et al.*, 2014; Jacyna *et al.*, 2014). Hence UNEP<sup>1</sup> together with FIA<sup>2</sup>, IEA<sup>3</sup> and ITF<sup>4</sup> has launched the campaign “50-by-50”, which aim is to improve efficiency of the global fleet at the least by 50% by 2050 (Rothengatter *et al.*, 2011). One of the ways to achieve this goal is to shift trips from private vehicles to public transport without loss of population mobility.

It can be ensured in a great measure by increasing quality of the transport system management in the cities. The high-quality management could be achieved through the introduction of systemic solutions, which allow both strategic and operational management of the city transport system, where public transport is one of sub-systems. The strategic objectives are defined for the long term. In such situation, the quality control criteria are improvement of system safety, reliability and stability. The correctness of such system operation is largely determined by the quality of initial information as well as by the adequacy of its processing methods. To ensure these parameters, it is essential to have (Verbas and Mahmassani, 2015; Weia *et al.*, 2015):

- module to collect, to store and to administrate information about parameters of transport systems as well as data about monitoring of parameters concerning vehicle and pedestrian flows;
- module to process and to analyse information for choice of possible optimal solutions (automated timetable scheduling of public transport, redirection of public transport vehicle fleet on the alternative routes, optimization of vehicle fleet structure on the routes in accordance with transport demand of population, etc.);
- module to support a management decision making, which chooses the best decision from the proposed alternatives to use it in the same sort of situation.

The intellectual core of the system is a transport model, which is built in a special package PTV VISUM (Celko *et al.*, 2009). Based on the computer experiment, load levels on the segments of road network are calculated and, as a result, problem areas are identified, which need optimization. After the verification and validation the model can be used to correct a city route network in order to avoid congested areas by buses (Autey *et al.*, 2013). The

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<sup>1</sup> UNEP – United Nations Environment Programme

<sup>2</sup> FIA – Fédération Internationale de l'Automobile

<sup>3</sup> IEA – International Energy Agency

<sup>4</sup> ITF – International Transport Forum

recommendations how to improve the bus route network are checked on this model with aim to predict the possible consequences of the proposed solutions.

This paper describes the public transport management system in the city, which allows to make strategic decisions, whereby the efficiency of transport processes are increased by means of efficient use of vehicle fleet, optimal public transport routes, etc. (Fierek and Zak, 2012; Jiménez and Román, 2016). In addition, the presence of feedback gives a possibility to react on changes of system parameters and, thereby, to carry out operational management. The current system parameters are compared with the model: in the case of mismatch, the reasons of problem situations are identified and an efficient management approach is selected. Such solutions make possible to increase the sustainability and safety of the transport system as well as to reduce the negative impact on the environment.

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## MANIFESTATION AND RECORD OF THE EXTERNALITIES IN THE TRANSPORT SERVICES IMPLEMENTATION

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**Keywords:** externalities, internalization, environment, transport services

Economic theory (Katz and Rosen, 1994; Fischer *et al.*, 1988) determines the external effects (externalities) as a reflection of situations of market failure when the costs or benefits of market transactions are not entirely accounted in the prices. The reason for the existence of external effects may be the fact that the consumption or production of some good may have side effects on the consumption or the production of another good. The inability of the market to ensure efficiency is usually regarded as a ground for government intervention in the economy.

The goal of this paper is to explain the reasons for the origin of externalities in the transport business, and considering the possible ways of overcoming them.

The development of transport presents excellent examples of the emergence of both negative and positive external effects.

The most obvious example of the negative effects is the pollution of the environment. As it is known, transport can have negative effects on almost all components of the biosphere: atmosphere, water, land, lithosphere and humans (Mirzabekova, 2008).

A positive externality occurs when one economic agent benefits from the activities of another agent. In this case, marginal social benefits (MSB) are formed not only by marginal private benefits (MPB), but also by given the marginal external effects (MEB) as it is shown in formula 1.

$$\text{MSB} = \text{MPB} + \text{MEB} \tag{1}$$

The marginal external effect in such a situation is the marginal benefit received by third parties who are neither buyers nor sellers. Referring to the transport business, it means that society as a whole and each of its members benefit from the transport system capable of providing the needs of the economy.

Transport services are a product offered by competing sellers (transport operators of different modes of transport). However, it is doubtful that every economic agent taking the decision about the trip (passenger transport) or the transportation of cargo to specific addresses (freight transport), thinks about the benefits which the society receives. Taking the decision, the rational consumer of transport services relates to the costs associated with transportation, and the benefits that can be obtained result. It is not surprising that investments in the transport sector may be less than optimal for society.

The recording of external costs, aimed at reducing market failures is to adjust the marginal private costs and benefits so that they reflect social marginal costs and benefits. It can be achieved by transforming the external effects (externalities) in the internal effects (internalities).

Internalization of negative external effects is provided by the increase in marginal private costs by the value of marginal external effects, which will lead to the increase of the good price and reduction of benefits it offers to the optimum level. The system of taxes is the main instrument in the transport business and in other sectors of the economy; concerning vehicles there should be differentiated taxes depending on the degree of negative impact on the environment.

Record of the positive external effects by their internalization means an increase in the marginal private benefits by marginal external benefits value. This adjustment stimulates a reallocation of resources towards their more efficient employment, which results in elimination of inefficiency. In respect of transport services such adjustment permits to facilitate the more rational distribution of passenger and cargo traffic by types of transport in accordance with their technical and economic characteristics.

The relevance of the research of record and real impact on externalities in the transport business, especially the negative ones, is increasing in the context of the Paris climate agreement 2015 (Anon, 2015), according to which it is planned to perform the situation analysis on the level of emissions and the overall progress of accomplishing the Paris commitments in 2018 with subsequent monitoring every 5 years. In relation to transport as one of the major polluting factors, the global environmental objective is to be achieved through adoption of well-grounded economic decisions at the national level.

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## INTERESTS IN MONITORING STANDARD OF TRANSIT TIME ON SLOVAK MARKET

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**Keywords:** standards, transit time, questionnaire survey, postal items, EN13850, postal operator

Postal operators have to apply many standards to practical life. Every of these standards are too variety and people usually do know anything about standards which have to be measure or calculated. Standard of transit time (EN 13850) is one of them. People knows that the postal items should be delivered on time but some people do not check this transit time on the other hand there are companies which check transit time very strictly.

It is important to know how many percent of population on each area is checking the transit time. For monitoring of interest there are many methods which can be applied but in this paper will chose questionnaire survey. We focused on common people but also on companies. Results of this survey are useful for national postal operator on Slovak market. There is information about which kind of people often check transit time and also which kind of items have been checked.

In conclusion of this article authors are formulated recommendations for postal operator to achieve more satisfied customers.

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## ANALYSIS OF THE KEY THREATS TO THE SECURITY OF LARGE INFRASTRUCTURE OBJECTS

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**Keywords:** transport security, civil aviation, airport infrastructure

The article discusses the problem of creating an integrated security system for transport, interest in which it has now reached the apogee. The reason for this is to understand that the further development of safety systems is not possible without the integration of the efforts of all stakeholders.

In addition, this article will be considered main security threats that may arise during big congestion people. In article are taken major infrastructure objects of the civil aviation, such as airports, terminals, runways, and many others. The experience of the past years have taken the basic problems and presented possible solutions.

Article will cover the following security threats:

- fire alarm and fire extinguishing systems;
- sound notification system;
- people evacuated;
- video monitoring;
- the prevention of disorder;
- system access control;
- prevention of terrorist threats.

This article will further used in the development of complex methods of security threats on large objects of civil aviation.

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## **ROBUST METHOD FOR PROTECTING ELECTRONIC DOCUMENT ON WATERWAY TRANSPORT WITH STEGANOGRAPHIC MEANS BY EMBEDDING DIGITAL WATERMARKS INTO IMAGES**

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**Keywords:** stenography, water transport, data protection

A huge number of electronic documents, circulating in computer networks is the basis for raising the important task of protecting information stored in these documents. It is necessary to protect documents from unauthorized access or deliberate distortion of messages.

As water transport depends on the availability of safe controls, navigation and communication systems, special attention should be paid to the technological updating of industry, the implementation of high-performance automation systems and use of innovative technologies. To store and transfer such vast amounts of information relevant automation system is required, which allows making the entire procedure of processing the documents of various kinds safe. Thus, the development of information technologies in transport companies and, in particular, on ships is directly related to the establishment of information processing systems.

The scope of this paper is the development and analysis of algorithms for implementation of the digital watermark (DWM) on the basis of the brightness modulation in blocks of graphic documents, allowing at the same time providing covert insertion of any sequence of a given amount of information and authentication of the image, in which Digital Watermark was incorporated.

To enhance the robustness of embedded digital watermark attachments, it is required to apply the same transformations in compression of graphic documents in stegoalgorithm like in the compression algorithms for these files.

In the case where the format of graphic images uses lossy compression, the classical methods of concealment in the pictures, as a rule, are ineffective, because while losing the information destruction of hidden information occurs by virtue of a small amplitude of the signal hidden.

The most widespread format is JPEG. Therefore, the format is presented in this paper.

The most important feature of JPEG is to use a direct discrete cosine transformation.

The purpose of this transformation is to move from a spatial representation of the image to the spectral one (space of frequency variations in brightness and hue). It is at this stage, when most of the algorithms introduces digital watermark as a graphic document. If one does not move on to this stage, and to take advantage of the dependence of luminance values of neighbouring blocks of pixels, it may be concluded that, since the luminance component undergoes smaller changes, it is possible to produce embedding of the information into this parameter.

The proposed method is based on the well-known QIM method (Quantization Index Modulation) with use of pixel brightness modulation of the image.

Protection is effected by embedding a digital watermark into an original protected image. The above algorithm can simultaneously provide covert insertion of any sequence of a given amount of information and graphic document authentication. This method is resistant to geometrical attacks on stegocontainer, such as framing, rotations, multiple 90°, and partial removal of information from the area of the image container.

Duplication of the embedded hidden information, based on a pseudo-random distribution of blocks in a graphic document enhances the security of a digital watermark from external influences on geometric stegocontainer. At the same time, block-check of the information sequence by finding the same key elements allows to identify possible areas for modification of the image.

The algorithm does not require the use of extra procedures of preprocessing (such as encryption) of the digital watermark image.

The algorithm does not require the use of fixed digital watermark to detect modifications, which provides digital watermark resistance to so-called "attack with a fixed DWM» (water mark template attack, deliberate attack of an experienced intruder making possible to modify images, even in the presence of a built DWM).

The algorithm performs faster by utilizing brightness modulation rather than calculating matrixes of discrete cosine transformation.

Using the redistribution of brightness as a basis for withholding the information gives unlimited possibilities to improve the algorithm. One can use different algorithms for brightness distribution within the block for tighter implementation bits of the digital watermark and for correction of boundaries of blocks with a pronounced redistribution of brightness.

# SAFETY AND SECURITY OF PASSENGER TERMINAL: THE CASE STUDY OF RIGA INTERNATIONAL COACH TERMINAL

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**Keywords:** passenger terminal, safety, security, risk, analysis, process, management

The concept of safety and security plays an important role in the European transport policy and significant aspect of the service quality provided to passengers. Because of the concentration of vehicles and passengers' accumulation on passenger terminals, the problem of increasing the level of safety and security in terminal becomes also more significant.

Transport safety and security are fundamentally different in that they focus on very different types of risks. "Safety risks" originate from unintended failures, errors or misfortunes whereas "security risks" originate from deliberate or malicious attempts to disrupt, disable or destroy (Ranger, 2010). In OECD report (2010) Louis Ranger mentioned that transport "safety" can rely on well-established legislative frameworks, a long history of practices, sophisticated data bases, targeted education programs and long-term action plans, otherwise, the security problem is less well quantified or recognized.

This study presents the Riga International Coach Terminal (RICT) safety management system and security concept. RICT management board considers the enterprise risk management as a multi-step process, which aims to reduce or compensate for the object upon the occurrence of adverse events. Authors analyses all documents which determine safety policies and procedures at RICT, define the responsibilities and accountabilities for safety, identify and classify risks. The safety management system is a formal framework that helps RICT management integrates safety into their day-to-day operations.

Authors analyse European documents and tendency to ensure adequate security in the operation of Passenger Terminal and present RICT security risk-based decision-making approach. It is based on the security organization setup, which includes interfaces with internal and external bodies and risk based strategy, implemented through a structured security, risk management process.

These results and initiatives in Riga International Coach Terminal (RICT) are important steps to create safeguard of the "sustainability" perspective, which implementation in whole redefine the RICT reliable node of public transport.

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## DEVELOPMENT OF INTERACTIVE MONITORING SYSTEM FOR URBAN ENVIRONMENTAL IMPACT ASSESSMENT OF TRANSPORT SYSTEM

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**Keywords:** monitoring, environmental pollution, traffic flows, Gaussian model, health, big data

Road transport is one of the main sources of greenhouse gas (GHG) emissions as well as air and noise pollution in cities today. To understand importance and actuality of this issue it is necessary to pay attention to the main transport strategic document in the European Union: White Paper 2011 on Transport “Towards a competitive and resource efficient transport system” (European Commission, 2011). Between numbers of global and local problems and goals mentioned in this document it is possible to point out following of them:

- Unfortunately, the transport system is not still sustainable: its negative impacts on environment, economy and society are quite large.
- Transport sector is the biggest producer of greenhouse gas emissions (GHGs) comparing to other branches of economy. This sector must reduce 60% of GHGs by 2050 in comparison to the level of 1990.
- Urban transport is a reason of approximately 25% of CO<sub>2</sub> emissions made by all transport.
- During the last decades transport started to be cleaner, but because of increased traffic volume it is still the main source of air and noise pollution. Cities suffer a lot for this reason. There are a number of suggestions and measures proposed and presented by White Paper 2011 to reduce level of their negative impact, especially, on urban areas.

Thereby, it is clear that research of negative transport impact on environment, especially, in the city as well as its assessment and monitoring plays an important role both for searching, finding and making of decisions for problems in transport sector which were declared as a part of global ones in terms of the whole European Union as well as for realization of projects and measures which will help to achieve goals mentioned above.

Current state of research in the chosen field shows some gaps and problems. In the one hand, interactive systems of environmental monitoring and assessment are successfully created and developed in different countries. For example, special systems were implemented in South Africa relating to monitoring of natural and climatic phenomena (Rorich and Sakulski, 2001; Sakulski, 2000). On the other hand, there are not any world-known on-the-fly systems for monitoring of transport impact on urban environment.

The article describes and explains the main aspects of interactive monitoring system development, which include traffic flow modelling, calculation of dispersion fields for different pollutants, assessment of population health risk as well as research, analysis and processing of so-called Big Data. There are a lot of research works in the field of traffic flow modelling. For example, the development of traffic flow models which take into account also traffic jams

reached significant progress during the last years (Kerner, 2009). Within the scope of presented paper, the existing models and algorithm were analysed to choose and to adapt one of them for needs of monitoring system. There is a special methodology for calculation of pollutant emissions and assessment of population health risk. The best experience in this field is approaches and methods which correspond to up-to-date standards of the United States and European Union. In this case it is also important to note scientific works done by scientist S.L. Avaliani (1997). Work with large available databases (so-called Big Data) is one of trends in all science spheres (Pashkevich, 2014). The paper (Pashkevich and Karamshuk, 2014) presents an example of such research in the perspective of cycling mobility. Database analysis will be also a part of the system creation process. The main focus is concerted on database concerning traffic flow information and its processing.

The article includes also an example of such interactive monitoring system, which was realized in Nizhny Novgorod.

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## SOME METHODS OF INCREASING THE EFFICIENCY OF RIVER TRANSPORT SYSTEM

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**Keywords:** waterways, cargo, vessel, optimization, transport corridors, river transport

The market relations impose to river transport the strict requirements on acceleration of cargo and passengers delivery at the smallest costs of transportation, on decrease of the transport component in prime cost of production, on improvement of quality and reliability of transportations.

The current trends of transport services development compel the various types of transport to pass from direct fierce competition among themselves to more mutually beneficial cooperation within intermodal transportations. Development of such transportations in Russia is closely connected with situation on the all-European market of goods and transport services.

A significant role in the integration processes belongs to the creation of conditions for free rendering of services on international transportations river-sea. The river transport provides the realization of transit potential of Russia within the international transport corridors. The integration world processes directly affect the interests of the Russian Federation which according to the Partnership and Cooperation Agreement with the EU assumed certain obligations for opening of inland waterways for the international navigation.

The transport corridors are elements of the international logistic structure. They are intended for achievement of bigger efficiency of transport process that is provided by application of the latest developments in technic, technology of the organization of transport and reloading process, and also by creating of favourable conditions for the transportations implementation.

The transport corridors are the powerful trunklines corresponding to the requirements of the international standards with uniform technological organizational legal norms and conditions. They allow to achieve considerable decrease in terms and cost of transportations, increase of their quality and reliability.

The active integration into the system of the international transport corridors creates the additional opportunities for development of the Russian transport system and further improvement of its industrial, information and technological infrastructure.

The uniform technology of cargoes transportation in the transport corridors assumes a continuity of the transport process with minimization (elimination) of faulty situations, first of all, in the reloading points (distribution centres) and, including, in river ports. Such system demands the optimization of distribution centres, definition of the optimum transportations plan, detailed calculations of types and number of vehicles, cargo handling equipment and other resources, as well as coordination of different work technologies of each type of transport, work coordination of the trunkline transport and cargo owners in the transfer points.

All these issues are solved by using the methods of "physical" distribution of cargoes, logistics and economic mathematical simulation. However, besides the traditional economic-mathematical methods for efficiency calculation of similar systems it is possible to use the mathematical apparatus of the mass service theory and also the algorithms of discrete mathematics.

We will consider the river system including initial, final and the intermediate transit points connected by river arteries, channels and locks. From the point of view of the mass

service theory, the similar system (or less difficult) can be considered as set of the mass service systems (MSS) with expectation which are consistently connected with each other so that the flow of the served requests (vessels) coming out from one system is the flow coming in the following system. Such systems connection is multiphase MSS with expectation. Each component of system is called as a phase. The incoming flow of requests for multiphase MSS is the stream coming in the first phase; the outgoing flow is the stream coming out from the last phase.

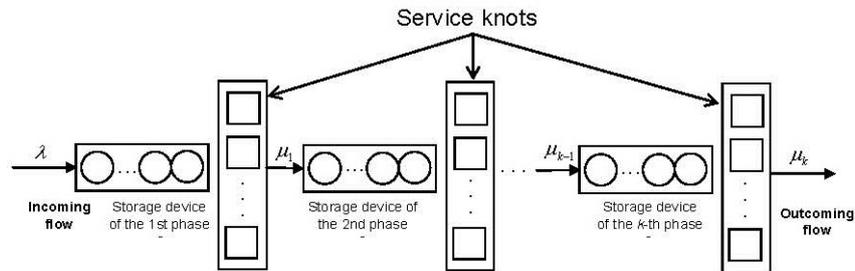


Figure 1. The scheme of multiphase MSS with expectation

The distribution of service channels set to some groups (service knots) is characteristic for systems of multiphase service. The transit points (river ports) and locks can be considered as knots on the inland waterways.

Deficiency of warehouse spaces is observed almost in all ports therefore their effective use promises considerable benefits for transshipment complexes. This problem is connected with the rational distribution on warehouse spaces of a port, and also the reduction of periods of cargoes storage in a port. At the same time the problems solution of cargoes placement is applicable not only for warehouse operations. The similar procedures can be applied, in particular, for the tasks of rational completing of freights at a cargo-planning.

Passing on the tree in search of the most rational decision meeting the requirements of efficiency, applying such algorithms as "search with exclusions", "annealing imitation", "ant algorithm", we will receive a set of decisions. From the received decisions it is necessary to make a choice of the most rational solution, perhaps, with revision of the efficiency requirements.



Session 3

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## **Transport Logistics**

# DANGEROUS GOODS TRANSPORTATION IN GREEN TRANSPORT CORRIDORS IN THE BALTIC SEA REGION – CASES AND RECOMMENDATIONS

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**Keywords:** green transport corridors, dangerous goods, risk management, mitigation measures

The Green Corridor concept represents a cornerstone in the development and implementation of integrated and sustainable transport solutions based on trans-nationality, multi-modality and a high involvement of public and private stakeholders, including the political level. Despite the fact that the Green Transport Corridor concept is founded on the three dimensions of sustainability with a strong emphasis on environmental aspects, the corridor hubs as well as the whole transport corridors have to find ways to handle and transport dangerous goods by keeping the high sustainability standards.

The paper addresses the research questions what kind of economical, ecological and social risks might occur in the context of handling and transportation of dangerous goods in a Green Transport Corridor in the Baltic Sea Region and how and with which measures they can be mitigated. Based on this analysis the development of a comprehensive risk management concept for the handling and transportation of dangerous goods in Green Transport Corridors in the Baltic Sea Region will be started. The concept will include practical implications and best practices.

## Reference

1. JEL Classifications: O14; 033

## DEVELOPMENT OF RECOMMENDATIONS TO REDUCE LOGISTICS COSTS IN TERMINAL NETWORK MULTIMODAL TRANSPORTATION

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**Keywords:** multimodal transportation, the terminal network, the terminal network, minimization of logistics costs, logistics costs

Logistics costs are considered as unaccounted losses - consequences of deviations of technical and economic factors taken into account from logistics costs. The task of transport logistics is the minimization of logistics costs of the articles unaccounted for by their "transfer" them into the category of planned and operated logistical costs.

Classification of logistic costs according to their attributes is the basis of the organization of the accounting and analyzing of logistics costs and management. Reducing logistics costs in international transport is impossible without the development of common principles. We can achieve effective reduction due to the usage of international transport corridors, cross-docking, freight consolidation, transportation outsourcing and optimization of warehouse processes. Classification of logistics operations implementation of appropriate encodings will allow you to move to a unified electronic document management.

The implementation of improved credit and clearing mechanisms will allow creating effective and reliable settlement system. The most difficult seems to be «transfer» into the category of planned and managed logistics costs, so called transaction costs. To minimize them, it seems a logical decision to order a complex of services in delivery of cargoes from a specialized company providing logistic services through outsourcing. Responsibility for non-fulfilment of contractual obligations in time should be also distributed contract that translates opportunity costs in the category of predicted and taken into account.

The list of logistics services is extremely wide. Through rate logistics operator includes a set of operating logistic costs. In the end-to-end logistics operator tariff takes into account transaction costs and immobilization, in fact, shifting the operational, transactional and time risks of the cargo owner.

To encourage reduction in transport costs of multimodal transport in the transport and terminal network, it is proposed to develop the general principle of the approach to reducing costs on various modes of transport. Knowledge of common principles allows all participants of the transportation process to have benefits and plan their expenses.

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## IDENTIFICATION AND LOCALIZATION OF TRANSPORT UNITS FOR SELECTED COMPANY

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**Keywords:** RFID technology, sorting line, passive tag, transport unit, identification

Smart identification by automatic identification technologies currently plays an important role in all areas of the national economy. Article deals with research in field of automatic identification by selected components (signal front lights, pallet and containers) through radio-frequency identification technology (RFID) in conjunction with automotive industry. The aim of our research was to identify all RFID identifiers placed on selected components and to localize position signal front lights, which was stored on pallet. It also talks about software support for RFID technology, mainly about creation and configuration of RFID middleware – specialized software tool allowing mutual communication between two or several applications; also known as connector between various application components. All results had been measured in laboratory and also real condition. A special section is dedicated to description of the technical equipment used during measurements and concept of measurements in conjunction with localization as well as their results from MySQL database.

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IV -Institutional research - 9/KS/2016 - Intelligent package as a tool for research on physical influences on parcels at selected postal operators

IV -Institutional research - 5 / KS / 2016 - Identification of postal items and transport units in the logistics chain of postal operator

## INVEST APPROACH TO THE TRANSPORTATION SERVICES COST FORMATION

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**Keywords:** Consumer, logistics, efficiency, Huff's model, retailer, full costs

Nowadays, one of the main challenges of logistics is material flow distribution from the producer to the final consumer. Modern scientific methods and models pay attention to numerous tasks at different stages of the logistics system. But at the same time, the efficiency of modern logistics systems considered in isolated form from the problems of improving the society efficiency. At the same time there is a connection between the current expenses of trade organizations, industrial enterprises and consumer spending. Logistics principles should be used to assess the effectiveness of the system as a whole, consider customers also. The development of logistics approach based on consumer's cost-benefit opens new opportunities to improve their service and the efficiency of the logistics system.

The article examined influence of consumer on the logistics system efficiency; Defined it's place in the logistics system; Revealed prerequisites that determine necessity of considering consumers in logistics system; proposed models that describe the costs and revenues of the logistics system including customers; suggested logistics system efficiency evaluation method, which allows to modelling results when visiting various retailers.

### Acknowledged

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## Session 4

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# Logistics

## TECHNOLOGY AND SUSTAINABILITY OF FUTURE SUPPLY CHAIN

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**Keywords:** logistic business, sustainability, big data, robotics, artificial intelligence

Supply chain has attracted increased attention from industry partners and academia in this field, as well as from managerial decision makers. From social, environmental and economic perspectives, sustainable supply chain is the engine for a more competitive and unified European market. To be able to comply with these demands, future supply chain must be highly efficient, 'environmentally friendly' and cost-effective.

Supply chain processes must augment and change with massive injection of new technologies, robotics, artificial intelligence, big data approach, and contemporarily become more sustainable, considering the growing environmental challenges.

From materials handling to production and distribution, big data and robotics will change conditions and push further efficiency and customer service levels. At the same time environmental constraints become more severe, but the managerial approach must change transforming where possible these constraints in new opportunities of developing Logistic Business.

This research explores the main technological changes and the most advanced cases in sustainable Supply Chain. After a general overview of the present and future trends in these areas, some practical case and experiences will be quoted.

## FEASIBILITY ANALYSIS OF ESTABLISHING LOGISTICS CLUSTER IN LITHUANIA

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**Keywords:** logistics clusters, planning, infrastructure, feasibility analysis

The transport sector and the transport infrastructure meeting the current needs of society constitute one of the key elements that can ensure the ultimate implementation of these processes. Therefore, it is very important to have a well-developed road and railroad network, a sustainable transport system and be geared towards the latest tendencies of the international business.

According to the European Commission there is 3.8 billion t-km of goods transported each year in the European Union alone. 45% by road transport, 40% by sea transport, 9% by rail transport and 3% by inland waterways. Currently about 24% of such vehicles travels on their route completely empty, leading to poor effectiveness of whole European Union transport system, calculated weight-based and reaching only 43%.

Furthermore, according to the same European Commission calculations, an increase by 10% in effectiveness would result in almost 100 billion Euros costs savings. Under perfect circumstances an increase of nearly 30% of transport effectiveness is possible.

Seeking to achieve higher effectiveness of such transport systems, integration of different transport corridors and modes is required, thus creating regional logistics hubs, built around existing transport infrastructure: sea and inland waterways ports, airports, railroad and/or multimodal terminals.

In the framework of the on-going economic, political, technical and technological developments within the transport sector, logistics centres are gaining a gradually increasing significance, as the concept of a logistics centre itself is based on the following three rather important elements: territorial planning that covers in parallel rationalization of its infrastructure, quality of transportation services and inter-modality development.

In freight transport multimodal transport concept is realized in practice, developing three types of hubs: sea ports and land transport terminals and a new generation of logistics centres (LC). Logistics centres and transport terminals can be integrated into all modes of transport: road, rail, air and water transport. Different modes of integration create new opportunities for freight efficiency, optimize the use of vehicles, to improve the quality of freight services. In addition, in such centres companies of various types of business effectively interact with each other (not only in transport and logistics). Foreign experience suggests that in logistics centres and transport terminals in activity work of transport companies one may find other companies, which find their niches such as insurance companies, bank branches, information technology centres, transport research, consultancy and training companies. Usually these logistics centres and transport terminals with modern information technology systems are connected to international networks, making them more competitive in the international market of transport services.

Under further development, proper government, research institutions and private investors backing such hubs have a potential to become a fully operable logistics clusters.

The objective of paper is to analyse three different scenarios of creating logistics cluster (also referred as logistics centres) in three main locations: Vilnius, Kaunas and Klaipėda. Each

location has various pros and cons. Subject of special interest in this paper are the key strategic elements, which have the biggest impact on decision of the location.

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## LOGISTIC SYSTEMS EFFICIENCY INCREASE BASED ON THE SUPPLY CHAINS INTEGRATION

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**Keywords:** logistics system, supply chain, multilevel system of inventory disposition

The increase of supply chains (SC) management efficiency requires further theory and methodology development of this scientific direction, wherein, it is obvious that the most perspective solution of this problem is logistic functions and operations development and integration improving on all levels of logistics systems (LS) management.

The analysis of number of sources (Bowersox and Closs, 1996; Ballou, 2004; Christopher, 2004; Stock and Lambert, 2001) has shown that despite the growing volume of researches and obtained results, the following can be stated.

Firstly, in most part of these researches the simple logistic links (SLL) with one warehouse are examined instead of the logistic chains including several interrelated warehouses for stocks storage on every level.

Secondly, analytical models mainly describe interfunctional integration of the logistic operations and functions.

Thirdly, reduction costs possibilities in supply chains due to traditional methods (EOQ model, multi-nomenclature, multiple periods strategy and so on) in a certain sense have been exhausted.

The fundamentally new method of accounting the integral connections between elements is the model of S. Axsäter (2006). The essence is in joint consideration of two or more SLL, each of which can be described by EOQ model of Harries-Wilson (Harries, 1913). The peculiarity of this model is that on the lower level the stock expense submits to saw-form dependence, on the top level it is stage dependence.

However, the study (Lukinskiy *et al.*, 2011; Lukinskiy *et al.*, 2012; Lukinskiy *et al.*, 2013; Pishchylov, 2010) of the two-level linear model of S. Axsäter has shown that it reflects only a part of possible variants of the integrable logistic operations analytical description. During the process of model improving the following modifications were worked out:

- alternative stock expense variant at the supplier's warehouse (the top level);
- different variants of costs accounting for the current stocks storage;
- uninstantaneousness (gradual one) of the stock forming on the top level and others.

The main and modified models allow forming different ways of distributed, multi-nomenclature two- and three-level integrated supply chains.

Calculations were performed for the three types of supply chains. The first SC type was composed of independent SLL and optimized according to EOQ; the second type – with partial integration and coordination of SLL; the third one – in condition of all SLL integration. The calculation results analysis has indicated that the total costs reduction in supply chains is from 10 to 25 % due to the integration approach.

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## ANALYSIS OF PICKED UP FRACTION CHANGES ON THE PROCESS OF MANUAL WASTE SORTING

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**Keywords:** Waste management, waste processing, reverse logistics, simulation

The problem of proper organization of the waste management system is becoming more and more significant now a days. In Poland, regulations forcing municipalities to achieve by 2020, 50% recovery of weight fractions such as paper, metal, plastic and glass are the main factors contributing the need of undertaking new activities in the field of waste management.

Waste management system consists of: collection and transport, processing and treatment and finally storage and disposal (Bilitewski, 2010; Chowdhury, 2009; Finnveden *et al.*, 2006). Waste processing takes place in complex technical systems. Modern waste processing systems are unfortunately characterized by low efficiency. Currently, it is estimated that the efficiency of installations dealing with the sorting of municipal waste does not exceed 35%. In 2015 the authors of the article carried out waste morphology in the city of Wrocław (only selectively collected waste). On the basis of this research, authors set fractions suitable for re-use accounted for 77% of the total weight of waste sent to processing plants. Despite of observed significant development of systems due to automatic identification and waste sorting, systems using mainly work of people are still very common.

The main goal of this article is to analyse the impact of changes in the type of waste picked up, on consecutive workstations on the value of indicators used to evaluate the process of manual sorting of waste. The authors have developed a simulation model of sorting line. It takes into account the variability of the size of the waste stream moving through the sorting line and the volatility of employee productivity during the 8 hours shift. Waste stream volatility has been modelled on the basis of studies conducted in one of the Wrocław sorting plants owned by WPO ALBA S.A. Changes in employee productivity are more broadly described in (Kozłowski, 1998). The analysis of sorting line and individual workstations has been made on the basis of multi-criteria method described in more detail in (Giel *et al.*, 2016). The method is based on evaluation criteria such as efficiency of the line, total capacity achieved by the employees and the volatility of the performance of individual workstations. On the basis of this assessment method it is possible to determine the state of the tested system. As a result, it is possible to identify the weak points of the system and identify the actions required to undertake in order to improve the system.

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# APPLICATION OF LOSS RATES FOR PETROLEUM PRODUCTS DUE TO NATURAL WASTAGE IN CUSTOMS PROCEDURES

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**Keywords:** Loss, natural wastage, petroleum products, customs procedures

Due to its geographical location Latvia has always been a noteworthy transit country. Liquid petroleum products are transported through the country on a regular basis mainly by rail or pipelines. The customs authorities should be aware of the main principles of estimation of loss to prevent avoidance of duty payment in case of unauthorized loss during customs transit procedures, therefore this study more focus on correct implementation of loss of petroleum products.

The authors of the research have offered design an algorithm how customs authorities accept loss of petroleum products due to natural wastage. The customs authorities in Latvia should introduce a uniform practice regarding loss rates. Namely, for the quantities missing wherever it can be shown that the loss observed result solely from the nature of the goods, no customs debt shall be deemed to be incurred. The customs authorities have the rights to consult independent experts to determine whether losses have occurred due to the nature of goods. If it cannot be proved by an independent expert, customs authority shall only apply the standard rate of loss.

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## Session 5

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# **Transport and Logistics Systems Modelling**

## SIMULATION AND THE EMERGENCY DEPARTMENT OVERCROWDING PROBLEM

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**Keywords:** The emergency department overcrowding problem, urgent care center, Simulation based optimization, discrete-event simulation, stochastic systems

In this paper, a brief review on the emergency department overcrowding problem and its associated solution methodologies is presented. In addition, a case study of an urgent care center is investigated that demonstrates different simulation-based solution strategies to deal with the Emergency Department overcrowding problem. More precisely, a simulation study is conducted to identify critical aspects and propose possible scenarios to configure an urgent care center. Based on statistical data supported from an international competition for simulation, several discrete-event simulation models have been built to study the behavior of a planned system and identify the required resources such as number of procedure and examination rooms, number of doctors, assistants and nurses. Each model contains a specific simulation scenario. The solution scenario has been developed based on combining key elements of the different previously developed scenarios. These elements have been observed carefully through a verification process combined with a heuristic optimization approach to identify their impact on the performance of the system. In particular, different patient arrival patterns with specific proportional critical level have been investigated. In addition, two main responses have been observed namely, the Leave Without Being Seen (LWBS) percentage and staffing and operational costs.

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## LIFECYCLE BASED USER VALUE ANALYSIS OF RAIL-ROAD LEVEL CROSSINGS: PROBABILISTIC APPROACH USING MONTE CARLO SIMULATION

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**Keywords:** LCC, maintenance, probabilistic analysis, integrated LCA, uncertainty quantification

Railway operators are in continuous pressure to minimize maintenance and rehabilitation costs of infrastructures; at the same time they are expected to provide a reliable service by optimum allocation of natural and economical resources. Railway tracks and level crossings are long-lived assets where their service life stretch 30 to 100 years. Hence efforts are being done by various researchers and practitioners in the sector, to fulfil the **Reliability, Availability, Maintainability and Safety (RAMS)** demands during the whole lifecycle. Given that level crossings have long service life, they will be exposed to increasing axel loads, speeds and traffic volumes for longer times. The new modernized routes demand new plan, design and dimensioning with corresponding level of EU guidelines (EN 2004/50 EC) and according to the technical specifications for interoperability (TSI). For rail operators, these components with their different demands and lifespans are important framework for the construction and maintenance and can massively influence the performance and the lifecycle costs of the whole system. Rail operators need therefore, decision processes with which the performance and LCCA can be compared. So far, there exist barely studies that assess the whole lifecycle cost of level crossing systems. Infrastructure owner staffs possess knowledge about costs, maintenance, expected service life and system performance related to sustainability issues. This paper aims to show an approach that serve as a decision support whereby expert’s knowledge can directly be integrated by using a delphiround. A proposed methodology is illustrated by application examples using level crossings commonly used in Austria by Wiener Lokalbahnen. Lifecycle based user –product performance- expectations and economic imperatives could be incorporated through the development of key performance metrics. User values based on practical knowledge and experience of served to compare different lifecycle assessment scenarios. Assessment criteria are set by allocation percentages for value criteria under these criteria are the sub value – contingencies. These value criteria are defined by allocating weighting factors for construction, maintenance and sustainability (considering maintenance related operation limitations) respectively. Monte Carlo simulation is used for probabilistic scenario. The results of the Monte Carlo simulation using the different lifecycle assessment scenarios indicated that for instance asphalt and large paving slabs – level crossings have disadvantages in relation to maintenance relative to the other systems. Besides the technical performance and maintenance demand during the whole service life, the challenges such as inaccessibility of level crossed railways for maintenance action lead to declining quality of the whole system. In the assessment scenario where maintenance expenses have got larger weighting factor, the system Bodan is found to possess larger user value as compared to for example to large concrete paving slabs. On the other hand, concrete slabs show significantly bigger total lifecycle based user value index than most of the systems when more criteria are considered. The probabilistic scenario analysis

allows decision-makers to optimize the scenario selection and develop contingency planning, ensuring the final implemented scenario will provide as much value to infrastructure management. The approach facilitates the first step for the detailed LCCA of infrastructures by supporting experts and non-expert decision makers to get a quicker insight on system benefits as well as serve as a bridge to the practical application of more robust data-driven LCCA.

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## **SIMULATION MODELLING APPLICATION IN REAL-TIME SERVICE SYSTEMS REVIEW OF THE LITERATURE**

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**Keywords:** Transport Management System, Emulation, Real-Time Simulation

In the modern logistic systems planning and management, three promptness levels of solutions of the corresponding tasks are traditionally distinguished: the strategic (advanced planning), the tactical (mid-term planning) and the operational one (dispatching and real-time control). To solve the problems of strategic and tactical planning, universal systems of ERP (Enterprise Resource Planning) type are widely used. To solve the problems of tactical planning and operational control, dedicated systems of WMS (Warehouse Management System) and TMS (Transport Management System) types are used, which interact with ERP-type systems as a rule. It should be noted that commercial TMS-systems are dedicated to the solution of standard tasks of transportation logistics. In particular, within the framework of the «transport follow-up» function, TMS allows following any physical or administrative operation regarding transportation: traceability of transport event by event (shipping from A, arrival at B, customs clearance, etc.), reception tailoring, custom clearance, invoicing and booking documents, sending of transport alerts (delay, accident, non-forecast stops). However, there exist a lot of dedicated systems for operational service where means of transportation are used for a prompt delivery of staff to the points where the respective jobs must be done. As an example of such systems, Rescue Service (telephone number 112) could be mentioned as well as systems for repair and maintenance of various types of engineering equipment: electrical power networks, gas circuits, water supply networks and elevator facilities. To provide real-time control of such systems, dedicated software products are developed, the efficiency of which is not subject to any rigorous test as a rule. Any company using such a software product remains satisfied with its properties if the product helps to develop at least some physically realizable call service schedules when handling incoming calls on a real-time basis.

This paper presents the problem of using simulation modelling - both with a view of assessing the efficiency of online service systems control and improving such efficiency by applying simulation models within the framework of the corresponding control algorithms. In the first case, the model is used in emulation mode when it is used as a tool for creating various situations in servicing environment which interacts with the already used algorithms of dispatching and control. In the second case, the model is used in the real-time mode when it is used as a tool for checking candidate solutions to be taken in a specific on-the-spot situation. A review of literature is presented showing the experience of using simulation models both in emulation mode and in the mode of tracking real-time processes.

## CREATING A MODEL OF AN OPERATOR OF A SIMULATOR COMPLEX USING COMMONSENSE REASONING

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**Keywords:** commonsense reasoning, event calculus, simulator complex, intellectual agent

The task of creating a simulator complex for skills formation is an urgent task in specific professional fields. One of these professional fields is a railway marshalling yard. A series of simulator complexes, implemented in working practice of marshalling yards on the Russian Railways road network, was developed by joint efforts of Siberian State Transport University (STU), Novosibirsk State Technical University (NSTU) and SoftLab-NSK Co.Ltd.

General, the training process via simulator complexes is an interaction of two agents: a “learner” and a “teacher”. The teacher creates new tasks for the learner and is able to estimate learner’s actions. The learner is in position of a real-world operator of a device. Usually, the teacher is an experienced specialist. To improve training efficiency it seems reasonable to create an intellectual agent able to make the best decisions in every situation during the training and to explain why a certain decision was made. The explanation should be obvious and clear for a trainee. For this reason, it is necessary to create a world model of a real-world operator.

The paper proposes a method for creating an operator model. The method uses commonsense reasoning and is based on event calculus (Mueller, 2015). The using of commonsense reasoning allows simulating the way of making decisions by a real operator. The event calculus includes techniques to solve the frame problem, the ramification problem and the qualification problem. It allows solving deduction, abduction and postdiction problems, so the agent based on event calculus is able to make its own solution and judge a trainee’s solution. The created model allows agent to respond to changes in the simulated world. Provided that there is a connection between the agent and the simulator’s module responsible for the simulation of physical processes, agent’s decisions will affect the simulation.

As an example of simulator complex we used the simulator complex for marshalling yard operators.

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## Session 6

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# **Applications of Statistical Methods to Transport and Logistics**

# MATHEMATICAL METHODS IN LAND-USE ZONE ESTIMATION BASED ON PUBLIC TRANSPORT DATA

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**Keywords:** data mining, time series, clustering, zone estimation, transport planning, land-use

Nowadays, data sets are spreading continually, generated by different devices and systems. The public transport is also not an exception. The modern GPS based tracking systems and the electronic tickets are producing lots of data, and we could use them, for improving the service level. In most cases, these data are stored, and the service providers don't use the information they contain, what even more they deletes these data to save space. However, these data are process able with the modern devices and methods, and we can use them for obtaining information. Thanks to the spread of data mining, these tools are not appearing only in marketing research, but in the most various kind of scientific area too and they are advertising a new scientific revolution. Although the importance of these data sources is essential it is not widespread in transport planning only in some specific areas.

This paper presents a possible application of the digital raw materials, taking the public transport passengers boarding and alighting information as a base. The smart card systems store the number of boarding passengers and in some cases also the alighting values. From the passengers' boarding and alighting information in a stop point we can create a time series, which shows the behaviour type of the given stop points presented on graphic curves.

Based on these time series, we are able to deduce to the characteristics of the stop point's environment since the different land usage yields dissimilar stop usage with well-defined peak hours. With the distance measurement of time series it is possible to define how similar are two selected stop points and their environment for each other. For such kind of distance measurement several methods are known. With the help of different clustering processes, these distance data can be turned into groups and we can observe these groups of stop points.

These stop point clusters are defining separated zones. This is the basic step in transport modelling and the zones were determined by manual methods usually, until now. This paper shows the usage of distance measurement and clustering methods in public transportation presents the background of this kind of zone distribution technic and highlights the advantages and disadvantages of each method.

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## ESTIMATION OF ORIGIN-DESTINATION MATRICES BASED ON MARKOV CHAINS

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**Keywords:** Transport modelling; origin-destination matrices; Markov chains

The problem of estimating origin-destination matrices is very relevant today in the context of the development of intelligent transportation systems, transport models, etc. An entry of an origin-destination matrix contains a total number of users moving from one point of the transportation network to another. The problem of obtaining origin-destination flows is that they are not explicitly observable and we have to evaluate them indirectly. It is accepted to use various heuristic and statistical techniques for estimating origin-destination flows. The most popular approaches are gravity and entropy models (Vasil'eva *et al.*, 1981; Wilson, 1967), whose significant disadvantage is the use of indirect information about people's movements. Another approach considers the estimation of origin-destination flows according to the observations on traffic flows, so far these various methods have been developed (Vardi, 1996; Tebaldi and West, 1998 and others.). Within this approach such methods based on Markov representation of origin-destination flows (Khabarov *et al.*, 2012) are of interest. In this paper such a method is considered.

The method proposed can be generally described as follows. A transportation network of a city is described by an aperiodic Markov chain with discrete time and states of the chain are associated with network nodes (origins, internals and destinations), and transitions between states are associated with network links. Different types of chain states determine a canonical form of the matrix of transition probabilities. Transition probabilities between states of the chain are estimated by the method of maximum likelihood. The matrix of indirect transition probabilities is calculated based on the matrix of transition probabilities using a fundamental matrix of the Markov chain. Final origin-destination matrix between origins and destinations is counted using the matrix of indirect transition probabilities and the prior data on the traffic volume.

The comparison of properties between the method proposed and well-known statistical methods of origin-destination matrix estimation from the observational data is carried out on several examples in this paper. The method is illustrated in the transport model of Novosibirsk developed in the PTV VISUM software package. We study the properties of the 397x397 origin-destination matrices of Novosibirsk. Practical recommendations for implementing the method proposed are given.

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## STATISTIC ANALYSIS OF THE TERMS OF VOYAGE CHARTER PARTY' IMPACT ON THE CONCLUSION OF THE DEAL

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**Keywords:** terms of charter party, settlement of chartering deal, statistic analysis

Settlement the Voyage Charter Party (C/P) is a kind of a compromise based on the balance of Shipowner and Charterer interests. Any C/P accomplishes numerous terms and clauses detailing the voyage particulars but the only thing that can be discussed during the negotiations before the conclusion of a deal are the formulations of some C/P terms. Each party tries to insist for most favourable formulations and the results of the negotiations reflect in the level of freight rate.

The terms of C/P offer and their acceptability for each of the party were discussed a lot by Gorton (2009), Collins (2009) with a particular attenuation to the negotiation process expiry and offers exchange. Stopford (1997), Marchese (2001) justified market factors as prerequisites of C/P deal. But truly the problem of the settlement of C/P deal considering the impact of the offer wasn't formalized.

The objective under consideration is quantitative estimation of C/P terms impact upon the beneficial settlement of the C/P. Methods used to perform the research are non-parametric analysis and correlative-regressive analysis. This combination is explained by specific features of C/P terms: some of them are expressed numerically (loading and discharging rates, demurrage etc.); the rest of them have non-numeric nature (for instance, NOR issuance, cargo option etc.). Therefore, statistic analysis was carried out for two sets of charter provisions – “numeric” and “non-numeric”.

Correlative-regressive analysis of impact produced by numeric C/P terms has been performed under the clauses of C/P: freight rate; loading rates; discharging rates; demurrage rate; laycan interval; freight percentage to be paid within 3 days. Results of correlative analysis turned out to be quite anticipated: the most serious effect produced upon the settlement of the contract is brought by the freight rate; next in scale on impact – loading and discharging rates. The least affect is made by the freight percentage paid within the period of 3 days.

Non-parametric analysis of “non-numeric” C/P terms on the basis of mutual correlation table where all the essential data for the index calculation have been obtained to characterize the interaction between the particulars of given instance – Pearson correlation coefficient. On the basis of information obtained from the set of “non-numeric” C/P terms we chose those that have the frequency in accepted and rejected contracts with the most significant variances, i.e. NOR issuance (“www”, “free pratique”), ports of loading/discharging – 2 on range, laytime structure, cargo option. After that the Pearson correlative coefficient was calculated interactively for various sets of chosen terms. The maximum value of this index was for the set of: Sundays and Holidays Included; ports of loading – 2 on range; ports of discharging – 2 on range.

Eventually, in the process of statistic analysis there was constructed a model of “numeric” terms impact upon successful C/P conclusion and on the basis of non-parametric analysis there were identified “non-numeric” terms that have their own effect upon the process. We shall note that time period that cover offers are of great significance, as under various market situations increasing role of particular Charter terms can be observed. Nevertheless, suggested

methodological approach used for identification of charter terms impact upon the efficient Charter Party conclusion can be employed in any other situations.

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## BIG DATA – BIG CHALLENGES FOR APPLICATION IN TRANSPORT

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**Keywords:** Big data, definition, transport planning, traffic data, social media

The collection and exploitation of Big Data is not new, the acceleration in both the growth and velocity of exploitable data will trigger significant, and the use Big Data will matter across many application fields, including transport. But it is not linked to a single technological change. Rather, what has occurred is the confluence of new data collection mechanisms based on digital devices, greatly enhanced storage capacity and computing power as well as enhanced sensing and communication technologies (“Big data and transport”, 2016).

The definition of “Big Data” is still debated, till now there is no fixed definition - from 3 Vs till 6 Vs. Beyer *et.al.* in (2012) presented the following definition: “high volume, velocity and variety of data that demand cost-effective, innovative forms of processing for enhanced insight and decision making”. So, three following Vs:

- Volume, that is increasing exponentially - from Terabyte to Geopbyte;
- Velocity: high speed of data in and out;
- Variety: various formats, types, and structures, and as result - integration difficult.

The initial information on Big Data can be found in the McKinsey report (Manyika *et al.*, 2011).

These data, often unstructured and unregulated, must generate knowledge and effects on business world. Advanced analytics based on Big Data will help decision makers evaluate alternatives against an incredibly complex and dynamic set of risks and constraints. Where and which impacts are to be expected? In the paper author considers the three main classes of users of Big Data in the Transport sector and present an overview of the current state of the research in these areas. At first, for government needs it is included transport planning and modelling, congestion management, Intelligent Transport Systems (Yu *et.al.*, 2015) etc. The cases present the value of Big Data analytics for urban planning, intelligent transport and safety. Big data gives new commercial opportunities in the private sector: route planning and logistics (Lee and Kang, 2015), revenue management, travel industry etc. The challenging aspect of big data fusion using by person is in the extraction of needed information across multiple data sets for route and travel planning.

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## SHORT-TERM TRAFFIC FORECASTING USING MULTIVARIATE AUTOREGRESSIVE MODELS

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**Keywords:** traffic flow modelling, short-term forecasting, STARMA model, MARSS model

Since the 1970s short-term traffic forecasting has been an important part of most intelligent transport systems researches and implementations. Existing literature on this topic is very extensive and mostly based on univariate statistical models (Vlahogianni *et al.*, 2014). Statistical models like autoregressive moving average (ARMA) and space-time (ST) models are widely applied to traffic prediction or to data actualization in other types of models (Yurshevich, 2013). Recent developments in computer technologies and mathematical methodology allow researchers to utilize more complicated multivariate models for real-time traffic data.

The multivariate vector ARMA (VARMA) model (Lütkepohl, 2004) is widely used for forecasting short- and long-term dynamics of economic and social processes. Incorporation of spatial information, essential for traffic flows, into the VARMA model leads to its space-time modification denoted as STARMA (Pfeifer and Deutch, 1980). The spatial restrictions imposed in the STARMA model significantly reduces the number of coefficients that need to be estimated and alleviates identification problems that are common for multivariate time series modelling. The most basic (first-order) specification of the STARMA model is:

$$x_t = \phi_{10}x_{t-1} + \phi_{11}Wx_{t-1} - \theta_{10}v_{t-1} - \theta_{11}Wv_{t-1} + v_t, \quad (1)$$

where  $t$  is a moment of time,  $x_t$  and  $v_t$  are vectors of modelled characteristics and random components respectively,  $\phi_{10}$ ,  $\phi_{11}$ ,  $\theta_{10}$ ,  $\theta_{11}$  are vectors of unknown coefficients, and  $W$  is a matrix of spatial weights.

Another modern approach to time series forecasting is based on multivariate state space models. State space models (Durbin and Koopman, 2012) are a unified methodology for treating a wide range of time series prediction problems, including short-term traffic forecasting. The multivariate autoregressive state space (MARSS) model can be expressed as:

$$y_t = Mx_t + Dz_t + u_t, \quad (2)$$

$$x_t = \Phi x_{t-1} + v_t, \quad (3)$$

where  $x_t$  is a vector of the observed multivariate state of the process at time  $t$ ,  $y_t$  is a possibly time-dependent linear transformation of  $x_t$  with the addition of a regression on the vector  $z_t$  of known exogenous explanatory variables,  $u_t$  and  $v_t$  are i.i.d. random vectors, and  $M$ ,  $D$ ,  $\Phi$  are matrices of unknown coefficients. The equation (2) is usually denoted as an observation equation and the equation (3) as a state equation. The state space approach has advantages over the more widely used family of ARMA models due to its higher flexibility and more efficient computation procedures (via the Kalman filter and expectation-maximisation algorithm).

In this research we apply both STARMA and MARSS models for short-term traffic forecasting. The components of the traffic model are defined as: the  $x_t$  matrix represents state characteristics (traffic flow, average speed, congestion) of every loop on a road segment; the  $z_t$  matrix contains known exogenous regressors (section length, signalization plans, etc.). Also special attention is paid to resolution of the data (length of modelled time intervals).

The models are tested using a data sample, collected for a segment of the urban road network in Riga, Latvia.

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## USING THE MIN/MAX METHOD FOR REPLENISHMENT OF PICKING LOCATIONS

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**Keywords:** Min/Max method, replenishment of items, red card principle, picking process, picking locations

Suppose that one row rack storing system available in the definite warehouse. Each item is placed on separate pallet. Let it be physical picking system: walk and pick (Tomkins *et al.*, 2003). For this purpose picking area (PA) is established in this warehouse. Picking process will be realized by picking handling units (HU) and customer units (CU). Therefore ground level and first level of pallet racks are used as PA. The one picking location of each item consists of 2 pallets: 1 pallet on ground level and second one on the first level of rack. It is defined that replenishment – moving the item from storing area (SA) to PA- will occur if stock of definite item in picking location will achieve critical level. This approach is called as Red Card principle (RCP) of picking system (Apsalons, 2012). However some difficulties will appear using the RCP: it is difficult to determine amount of each item which is appropriate for a signal to do replenishment once again. This is because there is irregularity of removing amounts HU and CU from each location (Koster, 1999).

As solution of described problem above is Min/Max stock control system, referring to replenishment of items in picking locations. In this case RCP will determine appropriate critical level or signal in the warehouse management system. If stock of each definite item will be lower than this appropriate level then at same time replenishment will occur. We just keep in mind that Min/Max sock control system is pull – down system (Praude, 2013). It means that replenishment for each item will be realized in different time moment. This is exactly when stock level is lower than critical (Frazelle, 2002). Optimal RCP notes that in uninterrupted picking process will be 100% stock availability – there are no occasions of stock – out of any item. Authors have approved that using of Min/Max method for replenishment of picking location is sufficient that stock – out of definite item will not occur.

In order to demonstrate that Min/Max system in this case is valid, the mathematical modelling and algorithms are developed by authors. Both BQ Min/Max stock control system and BS Min/Max stock control system is appropriate for solution of determination of critical sock level. An imitation modelling is used to check this system as whole. The use of RCP and Min/Max algorithms is applied in case when replenishment will be allowed in uninterrupted picking process. Otherwise replenishment will be realized outside of picking process, and then it demands several picking locations for each item. The results of imitation modelling show that BQ Min/Max system is more adequate than BS Min/Max system because replenishment from SA to PA always will be done by full pallets, and there are no necessary to move separate HU or CU. However, progressively developing system G2M – goods to man picking system, BS Min/Max system could be usable, because replenishment from SA to PA will be realized by conveyors or automated systems. Finally we like to stress that BS Min/Max system will demand replenishment rarely than BQ system. This can be explained by replenishment volume of each item: in case of BS Min/Max system replenishment volume exceeds one pallet. It means that

choice of BQ or BS Min/Max system to aware RCP is not unequivocally. It depends on picking systems, storing systems, from the speed of the movements of goods, etc.

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Session 7

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# **Intelligent Transport Systems**

## ENCODER IMPROVEMENT FOR SIMPLE AMPLITUDE FULLY PARALLEL CLASSIFIERS BASED ON GREY CODES

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**Keywords:** FPGA, big data, classifier, Gray code

The problem of high data volumes high-speed processing becomes even more popular. One of the solutions for such problem is parallel computations in programmable logic (FPGA). This is confirmed in latest versions of server processors Xeon, where Intel uses elements of programmable logic (Shah, 2016).

The present article describes functionality of real-time classifier usable for data flow statistical parameters calculations, different modulation types symbol detecting and in other applications, where the fastest association of input signal sample is required with one of the predefined categories. The effective implementation of encoder with high number of bits for fully parallel classifier is provided based on Gray codes (Gray, 1953). The work is concluded with comparative analysis of encoder standard implementation and its optimized version for FPGAs manufactured by Xilinx Company.

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## THE IMPACT OF THE ELECTRONIC SERVICES TO THE UNIVERSAL POSTAL SERVICES

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**Keywords:** e-substitution, postal service, cost, price, universal service obligation, mail volume

Advances in technology are blurring the boundary between the delivery of communications via physical and electronics means. E-substitution has impacted the development of postal markets across the world, reaching various stages in different countries and the impact on mail volumes being dependent upon the type of mail sent and /or business sector.

Postal operators are faced with the challenge to construct medium/long term projection in a rapidly evolving market with e-substitution of postal services. Because of economies of scale in the sector, as mail volumes decline average costs increase ceteris paribus (mail volume reduction, in turns, causes a continuous uptrend in the unit costs of mail, since fixed costs of production are spread over fewer volumes). Rising costs might be compensated by efficiency gains and increasing prices, but the latter can also promote substitution to other ways of communication.

The increase in unit costs is greater for universal service providers, since such as an obligation makes their cost structure more rigid. Universal service providers cannot balance the increase in unit cost with price increases: such an increase, in fact, would accelerate e-substitution and might result also in the loss of volumes to competitors. Increasing prices may not be the answer as the reduced volume resulting would lead to a further increase in unit costs, potentially triggering a graveyard spiral. Under the condition that the postal operator providing the service is free to adapt its service level and its base cost to worsening conditions, it is still possible to work out ways to render the postal operator financially viable. However the requirement to provide a universal service (national geographically delivery coverage, five or six days a week service) imposes a number of rigidities on the cost structure of the universal service providers that seriously threaten its financial viability. Universal service providers may well find itself with a shrinking gap between its unit cost and unit revenue that cannot be dealt with, unless universal service requirements are changed.

This article assess the impact of universal service obligation constraints on the universal service providers cost structure as well as their combined effect, in a market environment characterized by the shrinking of volumes due to e-substitution. In the article will be uses a hedonic function to estimate the impacts on demand deriving from a reduction of delivery frequency, as well as quantify the impact on cost through an econometric model.

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VEGA - 1/0721/15 Research on the impact of postal services and telecommunication convergence on regulatory approaches in the postal sector.

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## PERFORMANCE ANALYSIS OF WIRELESS COMMUNICATIONS FOR V2G APPLICATIONS USING WPT TECHNOLOGY IN ENERGY TRANSFER

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**Keywords:** WPT, compensation, 802.11, network simulation, network latency

Electrical Vehicle (EV) requires the development of a Vehicle to Grid (V2G) communication system for managing the EV charging sessions. In V2G systems there is a great potential of Wireless Power Transfer (WPT) technology for contactless energy transfer to mobile objects also in the case when charging process takes place for vehicles that are really in motion. In this case for energy transfer support wireless data transfer channel between vehicle and grid just must be used and it is very attractive to use some standard wireless technology for wireless network. But there are restrictions that bring real-time processes in WPT-V2G system. Data network architecture, the restrictions for data packets delay for technologies based on standards IEEE 802.11 are under consideration.

For WPT with technology ICPT (Induction Coupled Power Transfer) "compensation" mechanism can be used. It is based on periodic measurement of certain parameters in the inductively coupled circuits for their further correction with the aim to maintain the efficiency of energy transfer. In a specific for WPT use case the data exchange between modules can be used for managing the process effectiveness. Our objective was to determine the specific requirements for the wireless data transmission channel used in effective compensation process.

The nature of links based on the radio channels, the access to the shared resource of these channels, interference between them, and changes in SNR (Signal to Noise Ratio) cause variable available bandwidth, variable packet delay and packet loss rate. This may prevent to the correct operation of the networked time-sensitive control applications.

Closing control loops for successful operation it is necessary to organize multiple streams of data between modules. For compensation in WPT high demands are formulated for the data channel delay time. High levels of electromagnetic interference are expected.

It is well known that the delay introduced by the network may degrade control performance or just make such control quite impossible (Krivchenkov and Saltanovs, 2014). The analysis and good estimation of the network bandwidth together with network latency will facilitate robust system designs. In publication (Krivchenkov and Saltanovs, 2014) such analysis for the networks based on 802.11 standards was presented and consideration for 802.15.1 was added in (Krivchenkov and Sedykh, 2015). In this paper the performances of the network based on 802.1 standards with different architecture and influence of SNR have been investigated.

The analytical model for the network characteristics estimations is presented; some configurations of the network were simulated using GPSS (General Purpose Simulation System) environment. The statistical data of total application data delivered to their respective destination every second, characteristics of link latency and others have been collected from the simulations. In different numeric experiments payload, wireless architectures, distances between hosts, physical layer radio link characteristics were changeable.

By analyzing data from analytical, simulation and physical experiments some recommendations are made for choosing appropriate configuration parameters of 802.11

networks to achieve satisfactory relationship between bandwidth and packet delay for the WPT-V2G applications.

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## A STRUCTURE OF ELECTROMAGNETIC FIELD IN THE RADIAL SECTORIAL CAVITY

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**Keywords:** sectorial resonator, boundary conditions, field components

The solution of the boundary value problem of the electromagnetic field in the radial sectorial resonator with perfectly conducting walls is considered. As it is known, the resonant cavity is a closed volume bounded by metallic walls. The electromagnetic waves can exist inside in it under certain conditions. The most common elements of microwave techniques are rectangular and cylindrical resonators (Jackson, 1998), while cavities with other geometries are analysed and used relatively rare.

Below a structure of electromagnetic waves in the radial sectorial cavity will be considered. The angular size of the resonator, the length and the height of it as well as the operating frequency are usually assumed to be given. The electromagnetic field structure components in the inner region of the cavity should be determined.

For a description of the field the cylindrical system of coordinates  $r, \varphi, z$  is used beginning at the vertex of the bottom wall of the resonator. The angles  $\varphi$  are measured from the axis of symmetry of this wall. The main practical interest from the point of view of ease excitation of oscillations are electric type wave  $E_{mnp}$  with  $p = 0$ , when there is only one component of the electric field, namely,  $E_z$ . It is oriented perpendicularly to the top and bottom walls of the cavity and does not suffer variations along the  $z$  axis.

Solutions for the all components of the field are obtained. If  $p = 0$ , they are described by spherical Bessel functions (Bateman and Erdélyi, 1953). They are visualized using the computing environment from MATLAB. Certain applications of these solutions such as calculation of microwave power combiners or dividers (Song *et al.*, 2009) are considered.

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# DYNAMICS OF INTERACTION BETWEEN THE ROAD SURFACE AND VEHICLE'S WHEEL IN FIBRE-OPTIC SYSTEM FOR AUTOMATIC WEIGHING IN MOTION OF TRANSPORT

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**Keywords:** weight-in-motion, fibre-optic pressure sensor, non-linear interaction, longitudinal and transverse oscillations in motion, measurement errors

The problem of measuring individual parameters of vehicles and their classification is one of the most important research topics in the field of transport telematics. It is important not only for development of intelligent systems used for planning and cargo fleet managing, but also for control of the legal use of transport infrastructure, for road surface protection from early destruction and for safety support on roads.

These tasks can be carried out using a WIM system - weighing vehicles in motion (Grakovski *et al.*, 2014). The system uses fibre-optic pressure sensors (FOS) as a system's detectors besides axle's weights, vehicle's speed and tyre contact patch width measurements it allows to determine the number of axles distance between axles and number of wheels on the axle.

The signal obtained with a fibre optic pressure sensor, was decomposed in a combination of odd and even components in previous studies (Grakovski *et al.*, 2015). The odd signal component is unstable in presence of distortions, presumably caused by longitudinal and transverse oscillations of vehicle in motion. These distortions can sufficiently affect on weighing accuracy.

Presented research responds the attempts to suppose of odd component of FOS signal in the form of non-linear combination of the derivatives of even component that allows formulating the mathematical model of the dynamics of "wheel-road" system. The interpretation and estimation of coefficients of supposed model allows compensating for longitudinal and transverse oscillations of vehicle that leads to a reduction of axle's weight measurements errors in motion.

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## SECONDARY PROCESSING OF RADAR SUBSURFACE SIGNALS FOR ROADWAY COVERAGE MONITORING

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**Keywords:** ground penetrating radar data, radar profile, inverse problem, secondary processing, algorithms of secondary processing

There is monitoring of the roadway's state with employment of various technical methods oriented on timely receiving the information about the state of the roadways. To research the inner structure of roadway coverage the specialized Ground Penetrating Radars (GPR) are widely used (Jol, 2009).

The secondary processing of the reflected signals in the process of RSP is implemented inefficiently with employment of specialised software applications developed by the producers of GPRs. The secondary processing is generating the two-dimensional and three-dimensional images of subsurface area with employment of the set of saved signals. The process of generating the images comprises the diverse methods of signals processing.

Radar profiles (two-dimensional images) give only a qualitative picture of the roadway structure and its state usually (Jol, 2009). The number of layers that form the road surface may be different, and it depends on the type of the road, its purpose and the local conditions. It is necessary to perform reconstruction of the pavement electro-physical characteristics with detection and identification of inner zones and objects of roadway Coverage. A considerable amount of experience and operator skill may be required to correctly interpret radar profiles. Reconstruction of electro-physical characteristics of the pavement structural elements is in essence identification of electro-physical characteristics of the pavement layers, which can be achieved by solving the inverse problem of radar subsurface probing.

We used the comparison method for investigated the inverse problem of roadway coverage radar probing in the frequency domain (Krainyukov and Kutev, 2007). To solving the direct problem of roadway coverage radar probing is performed taking into account: the parameters of the radar antenna system, the formation features of the probe signal by the impact excitation of the transmitting antenna and complex reflection coefficient of roadway coverage (Krainyukov and Kutev, 2011).

GPR SIR-30 with ground – coupled antenna 5103 performs subsurface probing in the range of 400 MHz. In this investigation we have carried out secondary processing of GPR SIR-30 subsurface signals. To solve the direct problem of radar probing calculation model has been developed for a complex transfer function of direct signal of ground – coupled antenna 5103. A complex transfer function of lateral signal has been refined also. The results of forward problem modelling demonstrate that the suggested calculated model of direct signals on the output of receiving antenna of the GPR SIR-30 prove the adequacy of the calculated model of channel of signals formation on the output of receiving antenna 5103 of the GPR SIR-3.

We performed investigations for reconstruction of electro-physical parameters of roadway coverage which consist of several layers. Electro-physical parameters for each model layer were thickness and relative dielectric permittivity of the layer's materials, which values were the same as ones for asphalt road pavement (Krainyukov, Kutev, 2011, 2013).

Genetic algorithm and artificial neural network were used in the work to secondary processing signals data from SIR-30 GPR. Efficiency of these algorithms was proved (Krainyukov and Kutev, 2011; Krainyukov and Kutev 2013; Opolchenov and Kutev, 2014) in radar subsurface probing inverse problem for the idealized models of road pavement. Efficiency

of mentioned above inverse problem solving methods applied to real imperfect signals from SIR-30 GPR under research in this work. Aspects of applying evolution algorithms for the GPR SIR-30 signals data were obtained.

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## METHODOLOGY OF OD MATRIX ESTIMATION BASED ON VIDEO RECORDINGS AND TRAFFIC COUNTS

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**Keywords:** OD matrix evaluation, traffic counts, video recording, TFlowFuzzy

Microscopic traffic modelling as the input data for traffic could use two types of data 1) OD matrixes; 2) input intensities for each entering point in the network (Barceló, 2010). The second approach is widely used by practitioners in case if the simulation area is not wide, includes number of crossroads and decisions which should be tested by the simulation are local. In case of the wider network, significant number of routes between origin and destination points and testing of the solutions which could lead to the distribution of the traffic flows across the network the OD matrixes seems feasible solution. In this case it is necessary to use in the model not the static routing, but the dynamic routing. The input for dynamic routing is OD matrix.

Usually the OD matrix could be obtained from macroscopic model of the city or district, but if the study area is too small and fits in one or few transport zones or there is no macroscopic model, the practitioners are faced to the problem of OD matrix evaluation for the study area (Peterson, 2007).

The goal of the paper is to describe in detail and demonstrate application of the methodology of OD matrix evaluation based on video recording and traffic counts done in the study area. The approbation of the methodology was done in Riga city in the area which covers part of few city districts. The study area was surrounded by the video recording devices (in total 14 sites for video recording) and during 1h15m the traffic was recorded in all 14 recording sites. In the same time manual counting of the traffic was performed in 5 main roads in the study area. Next the manual decoding of the video recording was performed, fixing the type of the vehicle and licence plate number for each recording site with split on incoming and outgoing traffic. This gave the information about origin and destination transport zones of the traffic flow and allows to construct initial OD matrix. The evaluated initial OD matrix was used to estimate the probability matrix, which describes the probability of driving to the different destinations from the origin. The probability matrix was necessary in order to include into the initial OD matrix the data about the vehicles, which did not reach the destination during video recording period of time or the licence plate number was missed, because of overlapping vehicles and quality of recording. The obtained updated OD matrix was calibrated based on TFlowFuzzy approach. The manual counting data were used for the calibration of OD matrix. Finally the OD matrix was manually checked by the group of experts.

The proposed methodology allows to estimate the OD matrix, which could be used for microscopic traffic modelling in case of dynamic routing application in the model.

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## Session 8

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# **Information Technologies in Transport and Logistics**

# THE ROLE OF COMMUNICATION AND META-COMMUNICATION IN SOFTWARE ENGINEERING WITH RELATION TO HUMAN ERRORS

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**Keywords:** defect prevention, Socio-cognitive modelling, IT project processes, TOGA meta-theory

This paper examines and focuses on some issues and questions relating to how the use of meta-communication concept in Software Engineering process to reduce human errors. In addition, the role of IT project communication and the project management tools which can be regarded as vital for Software Engineering are also investigated. In the field of Software Engineering the perception of the role of Socio-cognitive Engineering (SCE) is continuously increasing. Socio-cognitive modelling of Integrated Software Engineering using the TOGA meta-theory has been discussed. Today, the focus is especially on the identification of human and organization decisional errors caused by software developers and managers under high-risk conditions, as evident by analyzing reports on failed IP projects. Software Engineer's communication skills are listed. Several types of initial communication situations in decision-making useful for the diagnosis of Software developers' errors are considered. The developed models can be used for training the IT project management executive staff.

## HIERARCHICAL CRITERION MODEL FOR ARCHITECTURE SELECTION OF LOGISTICS AND TRANSPORT SOFTWARE

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**Keywords:** multicriteria decision analysis, criteria importance theory, decision making, software architecture, architectural patterns

The formation of architecture is the first and fundamental step in the software designing process that provides the framework of a software system, which can perform the full range of detailed requirements (Orlov, 2015; Bass *et al.*, 2013).

Most of the existing techniques for constructing a software architecture are not well formalized and usually are not based on any mathematical theory (Bass *et al.*, 2013). Therefore, the problem of software architecture selection and analysis based on quantitative valuation is very important. In other words, it would be desirable to have a formalized technique that is based on mathematical theory, and which allows analysing and making decisions when choosing software architecture or its components.

Some studies propose usage of the criteria of efficiency and the architecture efficiency metrics for quantitative evaluation of a software architecture (Orlov and Vishnyakov, 2010; Orlov and Vishnyakov, 2014). The disadvantage of this method is that the components of the architecture efficiency metric are explicitly defined, and we could not easily extend that to reflect required software architecture features.

This paper proposes a technique for software architecture evaluation that is based on criteria importance theory for decision making problems with a hierarchical criterion structure (Podinovski, 1994; Podinovski and Podinovskaya, 2014). It allows making decisions when choosing a software architecture system among several alternatives and lack the disadvantages existed for other methods. Having the model and the obtained values of software metrics for the considered software architectures, decision-maker could proceed to the selection of the optimal software architecture for logistics and transport systems with the specified requirements.

The software architecture selection technique consists of the following steps:

- Selection of software architecture metrics;
- Organization of the selected metrics into the software architecture metrics hierarchy;
- Unification and normalization of the selected metrics;
- Creation of the model based on criteria importance theory for decision-making problems with a hierarchical criterion structure. This step also includes definition of all relations between software metric groups and definition of all coefficients of importance;
- Selection of the alternative software architectures for the required software system;
- Obtaining values of each metric for every software architecture, i.e. formation of vector criterions;
- Solving the problem of criteria importance theory for decision-making problems with a hierarchical criterion structure.

Several case studies were conducted using different software architectures. For every software architecture alternative, the metrics values evaluated and corresponding vector estimate and NT-estimate obtained. The result of the case study proved the correctness of the proposed model, which is based on the criteria importance theory for decision making problems with a hierarchical criterion structure. During the case study, we identified the optimal software architecture for the transport system with the specified requirements.

The obtained results indicate that the proposed technique is applicable for solving problems of selection of optimal software architecture

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## LOGISTICAL COSTS MINIMIZATION FOR DELIVERY OF SHOT LOTS BY USING LOGISTICAL INFORMATION SYSTEMS

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**Keywords:** supply chain management, delivery route, delivery schedule, modules of decision support system

Producers and suppliers of essential goods require specific development strategies to work in the sharp competitive environment. These strategies must allow, on the one hand, to reduce expenses and, on the other hand, to find reserves how to increase profitability of production and delivery processes. As far as transport costs create always the largest part of logistical costs, to improve economical effectivity of processes at the company is possible by reducing empty legs by product delivery, effective use of vehicle fleet, construction of new rational transport routes as well as implementation of logistical information systems (LIS) (Dondo and Cerdá, 2015).

Data management in the LIS provides all kinds of operations, which are necessary to execute orders of cargo transportation, to control operations and to evaluate of their effectiveness. At the same time, one of the most important LIS functions is routing and creation of the transportation plan, which could be increasingly realized by both analytical and simulation modelling. In such models, the choice of the best possible decisions can be made by direct search method. However, such kind of search requires often significant resources often, because there is a large amount of feasible solutions. At the same time, the existing directed search methods to find effective management solutions involve computer experiments. Thus, the design of a decision support system (DSS) to improve the management of logistics processes in enterprises, which have an extensive network of dealers and carry out deliveries of shot lots, is an actual task (Patila and Divekarb, 2014; Zhang *et al.*, 2016).

Considering that the quality of decision-making depends on quality and actuality of information, databases are created and continuously updated (Battini *et al.*, 2013; Kaneko and Nojiri, 2008). They store data about goods, amount and type structure of vehicle fleet as well as location of manufacturing departments, distribution centre and all possible delivery points. Besides of that, these databases include different reference data such as standard time of loading-unloading operations, characteristics of street and road network (type and quality of surface, road width, limiting traffic load, etc.) and others (Baykasoglu and Kaplanoglu, 2015; Pamučar *et al.*, 2016).

Development of vehicle routes in relation to a city map could be realized by using the software package “Delivery Logistics”, which was created in mode “Managed Application” and based on the platform “1C:Enterprise” Version 8.3. However, this software does not take into account the real situation on the road by routing process. That is why an experiment based on the simulation model is the best approach to make a choice of an optimal alternative for the certain time interval. At the same time, the background for this choice is a knowledge warehouse that provides information about parameters of traffic flows as well as about the road

network state in different periods, which have been prepared based on the results of field observations.

This paper presents a case study in the city Naberezhnye Chelny. To process this case study, an analysis of the existing software packages was done. As a result, PTV Vision was selected as the most effective environment to solve the optimization problem of delivery routing: it allows to choose the best possible routes in terms of minimal costs taking into account congestion, road capacity, features of the city transport system and other aspects (Xiao and Konak, 2016).

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## Session 9

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# Aviation

## DESIGN OF EMBEDDED ARCHITECTURE FOR INTEGRATED DIAGNOSTICS IN AVIONICS DOMAIN

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**Keywords:** Embedded architecture; health and usage monitoring systems; integrated modular avionics

The present paper introduces a multi-level decision-making approach for design of optimal embedded integrated diagnostic architecture that combines maintenance decisions at the k-levels of system architecture and integration with health and usage monitoring systems (HUMS) mechanisms for achieving efficient system for level maintenance and lowering life-cycle cost of Integrated Modular Avionics (IMA). HUMS can be implemented in software or directly on an integrated circuit. The effectiveness of such an approach is investigated through the optimization of embedded HUMS architecture for known reliability and economic dependence during life cycle of IMA.

## OPTIMISATION METHODOLOGY OF A FULL-SCALE ACTIVE TWIST ROTOR BLADE

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**Keywords:** active twist, macro fibre composite (MFC), helicopter rotor blade, optimisation

During a flight of helicopter the rotor blades produce significant vibration and noise as a result of variations in rotor blade aerodynamic loads with blade azimuth angle. The high vibration in helicopter leads to discomfort of passenger, increase pilot workload, reduce component fatigue life, limit forward flight speeds and increase maintenance costs. For this reason future helicopters need to be improved with respect to environmental and public acceptance. The traditional vibration reduction technique was a passive approach using, with vibration isolators and absorbers. Later, new control techniques were developed. This strategy involves active approach such as Higher Harmonic Control and Individual Blade Control. With an emergence of active materials, the Active Twist Rotor (ATR) concept was proposed.

In the present study the ATR concept based on application of Macro Fiber Composite (MFC) actuator. The MFC consist of polyimide films with IDE-electrodes that are glued on the top and the bottom of piezoceramic fibers and oriented at  $\pm 45^{\circ}$  to blade spanwise axis. The interdigitated electrodes deliver the electric field required to activate the piezoelectric effect in the fibers and allows to invoke the stronger longitudinal piezoelectric effect along the length of the fibers. Due to properties and orientation of piezoelectric actuators the MFC actuators to induce shear stresses and thus distribute twisting moment along the blade. The actuators integrated and distributed into the rotor blade skin generate dynamic blade twist and camber adapted to the flight condition at any given time, which leads to significant vibration and noise reduction and improves flight performance.

The optimisation methodology based on the planning of experiments and response surface technique was developed for an optimum placement of MFC actuators in the composite rotor blade. The design methodology includes 5 stages. In the first stage, a plan of experiments is produced in dependence on the number of design variables and the number of experiments. In the second stage, the numerical model is created in order to model the response of a structure and then finite element analysis is performed in the reference points of experimental design. In the third stage, the numerical data obtained by the finite element calculations in the sample points is used in order to build approximating functions using response surface method. The non-linear optimisation problem is executed by the random search method using the obtained response surfaces in the next stage. The optimal result of non-linear optimisation is checked using the finite element solution in the fifth stage.

3D finite element model of the full-scale rotor blade were produced by commercial finite element software ANSYS. To confirm the modelling accuracy, a comparison of the torsion angles between 3D numerical simulation and experimental test of the demonstrator blade was made. To activate piezoelectric effect, the thermal analogy was used.

### Acknowledgements

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## MODELLING REGIONAL AIRPORT TERMINAL CAPACITY

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**Keywords:** regional airport, airport terminal dynamic capacity, levels of service

Optimisation of capacity becomes a key factor for ensuring regional airports existence at the beginning of the XXI century in Europe. Due to the operational profile, regional airports in Europe have a limited capability to increase the non-aviation revenue but on the other side, aviation revenue has been under pressure due to low-fare trends and competition not only between airlines but airports as well. Additionally, to be flexible at the airlines' suitable times of operations the size of largest aircraft for operations at regional airports is changed. Due to the evolution of regional routes and airlines' fleet in Europe, regional airports have to able to serve at the competitive level of service the aircraft with at least 160 seats like leisure charters or main carrier operation. This study analyses the regional airport terminal capacity with its application at Tartu Ülenurme Airport. From the point of view of dynamic capacity management, the created model is based on empirical data. According to the prepared scenarios, the research gives the input of possibilities for optimisation of regional airports' terminal capacity at reasonable level of services.

## THE ROLE OF ADVANCED TECHNOLOGIES OF VIBRATION DIAGNOSTICS TO PROVIDE EFFICIENCY OF HELICOPTER LIFE CYCLE

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**Keywords:** condition monitoring, vibration diagnostics, Health and Usage Monitoring Systems

Vibration diagnostic techniques application to helicopters is growing gradually both in production stage and technical operation and maintenance. The development of appropriate technologies requires considerable investment and is often hampered by the lack of a clear perspective, understanding of the possibilities and areas of application. The article presents new opportunities for the use of vibration technologies for helicopter diagnostics at different stages of its life cycle, providing increased efficiency of production and operation. In paper the taxonomy of vibration diagnostic techniques applicable to most of critical machines, mechanisms and structures of a helicopter is presented and discussed (Fig.1).

Helicopter life cycle includes two main stages: manufacture (production and overhaul) and operation (up to utilization). Nowadays at manufacture stage only few vibration parameters are measured on a testing rig during operation test. Typically it could be rotor harmonics and total vibration of engines or meshing (and side-band) frequencies of a gearbox. If any of above vibration parameters exceed limitations an aggregate to be returned for reprocessing. The list of reprocessing works is based on technical routines and experience but not by technical condition of the specific aggregate. Advanced vibration diagnostic techniques, briefly considered in the paper, allow identification of the failure in the testing process and provide both reduction of reprocessing works and costs saving. The paper illustrates effective diagnostic techniques applications on helicopter engines exceeded vibration limits in delivery trials. Detailed diagnostics of tested aggregates allows production quality control amplifying feed-back between final product features and control actions. As an example, article presents the case study of vibration diagnostics for planetary gears of the helicopter main gearbox, which allows managing the quality of their repairs. The absence of vibration diagnostics system during the test could cause large expenses due to the long time to identify the reason of defects.

In technical operation state-of-the-art Health and Usage Monitoring Systems (HUMS) are able to identify failures of a drive train and a gearbox (sometimes) however, engines monitoring is very limited (in best case). Certainly, acting HUMS reduces fatal cases however; its effectiveness is short in regards to main gearbox (particular to epicyclical gears) and even more to engines. Such critical parts as the main and tail rotors, its blades and aggregates are not under control during operation at all. Above limitations depress capabilities of a ground part of HUMS that is not able to monitor all crucial parts of a helicopter and to provide its condition based maintenance.

In the paper the capabilities of advanced vibration diagnostic techniques are considered using samples of experimental operating systems application. The application cases in diagnostics of latent failures in engines, bearings and rotating parts as helicopter blades and swash plate are discussed. On top of board systems, like HUMS, some opportunities of single vibration diagnostic survey are discussed. Such survey could be used during C-check or even

before utilization of helicopter to define technical condition of most costive aggregates aiming for recommendations regarding further aggregates application after removal from a board. The article includes photos of operating experimental systems for diagnostic techniques trial application and some data of experimental techniques verification.

Advanced vibration diagnostic techniques are possible platform to use of Failure Mode, Mechanism and Effect Analysis (FMMEA) for design of Health Monitoring Systems (HMS). In article the general approach of determining the diagnostic validity and accuracy of HMS using the vibration diagnostics technologies and application of HMS to provide condition-based maintenance for more efficiency of helicopter life cycle on criteria reliability/cost are discussed.

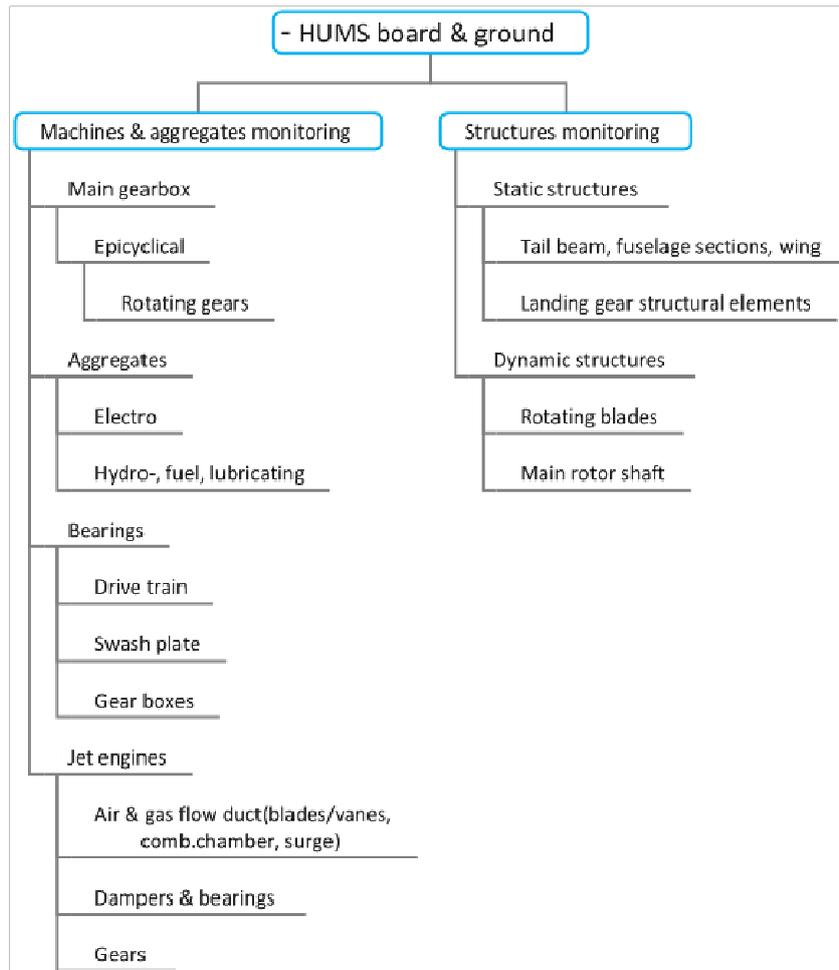


Figure 1. Taxonomy of advanced vibration diagnostic techniques for actual monitoring of helicopter aggregates

## BUILDING, VERIFYING AND VALIDATING A COLLISION AVOIDANCE MODEL FOR UNMANNED AERIAL VEHICLES

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**Keywords:** unmanned aerial vehicles, remotely piloted aircraft, collision avoidance, unregulated airspace, simulation, model

Present day commercial unmanned aerial vehicle (UAV) technology does not provide solid, reliable collision avoidance mechanisms (Lancovs, 2015). However, there are alternatives to using on board sensors, such as using broadcast transponders. An example is automatic dependent surveillance-broadcast (ADS-B) technology used in manned craft, but it does not transfer well to small UAV craft.

An alternative system was proposed, similar to ADS-B, but designed specifically for small, low flying commercial UAVs that do not require to enter controlled airspace (Lancovs, 2016). Such system needs to comply with strict safety regulations, especially if such craft would ever be used autonomously in urban areas – in no small part because it could be the only collision avoidance system on board.

As potential for human injury or death exists in case of failure, this system would be classified as “Class A” in manned aviation, posing strict reliability requirements (Youn *et al.*, 2015). Parameters of this system need to be determined to adequately cover all possible use scenarios, while maintaining a specific reliability level in each case.

Since these parameters are interdependent, a stepwise approach to designing such system was proposed (Lancovs, 2016). At each subsequent step new internal or external factors are introduced, while parameters are updated to maintain reliability. This approach relies on modelling collision avoidance at each step.

This article develops the proposed approach. A model was created to simulate UAV behaviour during collision avoidance. GazeboSim (Open Source Robotics Foundation, 2016) was chosen as modelling environment. A number of real UAVs were chosen, and their parameters were entered into the model. A course imitating actions during collision avoidance was flown by each craft.

Verification was performed by comparing output parameters for modelled craft, such as maximum speed and climb rate during the flight, to their definitions in the model. Course flown was compared to the planned course.

Validation was done by having real craft fly a mission with a flight plan that contains a similar course, and recording UAV telemetry. Real flights were performed using U|g|CS mission planning and flight control software (SPH Engineering, 2016).

Collision avoidance model was found adequate and therefore suitable for UAV collision avoidance simulation. It will be used to identify parameters for proposed collision avoidance system in further research.

### Acknowledgements

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## DIAGNOSTIC MODELS AND METHODS IN MONITORING TECHNICAL STATE OF AVIATION GAS TURBINE ENGINES

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**Keywords:** technical condition, gas turbine engine, monitoring, failure models, methods of diagnosis, on-board and ground control, standards

In the process of operation of aircraft gas turbine engine (GTE) may be in different technical conditions (Yunusov and Labendik, 2015), so the task of recognizing the state of technical state is assigned to the control and diagnostic systems.

Diagnostics of GTD technical state should solve two main tasks: ensuring the safety of the flight and reducing the cost of maintenance through early diagnosis of before-failure state of parts and engine components. These tasks define the principles of a rational structure of the monitoring system. This system is formed from closely interacting with each other on-board and ground-based sub-systems of monitoring and diagnostics. Sub-system of the control of technical state performs safety functions which ensures solving the problem of recognition of defects and damage at an early stage of their development and prognosis of before-failure state of engine components.

By monitoring of technical state should be understood as all complex tasks of controls and diagnostics of technical condition of the engine during operation. An important aspect in the construction of the monitoring system is the choice of models and methods that would ensure the effectiveness of the monitoring system (ISO / FDIS 13379: 2002). Overall monitoring process is represented in the ISO 13381-1 Standard – Condition monitoring and diagnostics of machines. Prognostics. This standard as the diagnostic model offers different models of failures.

Taking into account the specificity of monitoring of gas turbine engines, in the paper is proposed two-level classification of diagnostic models and methods used in the technical state of monitoring system. Models and methods of level 1 provides a control of the technical state of the engine, and are used in on-board monitoring and diagnostic systems, models of level 2 are designed for prediction of technical state of the engine, and are mainly used in ground-based diagnostic systems.

What is important is that the model of level 1 solve the problem of preparation of the data that will be used for models of level 2. This separation of models into levels gives a clear understanding of which model should be used in the construction of a monitoring system.

The paper reveals assignment of 1 and 2 level models and appropriateness of their use in the monitoring system.

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## Session 10

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# **Economics and Business**

## ANALYSIS OF SMALL AND MEDIUM SIZED ENTERPRISES' BUSINESS PERFORMANCE EVALUATION PRACTICE AT TRANSPORTATION AND STORAGE SERVICES SECTOR IN LATVIA

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**Keywords:** financial indicators, small and medium-sized enterprises, business performance

The term "performance" is used in the foreign research and academic literature to describe results of companies' business activities. The study on business performance measurement framework offered by the researchers (Kotāne, 2015) demonstrates that business performance measurement dimensions include indicators characterising both the companies' financial, and non-financial performance. Evaluation of the small and medium sized enterprises' (SME) business performance measurement and management framework and the business performance measurement practices (Jamil and Mohamed, 2011; Phihlela and Odunaike, 2012; Cocca and Alberti, 2010; Bianchi *et al.*, 2013; Olaru *et al.*, 2014) leads to the conclusion that an evolution towards a merger of financial and non-financial performance perspectives can be observed. However, despite the foreign practice, the evaluation of SMEs' business performance in Latvia can be conducted using only financial indicators.

In Latvia, the SMEs form a significant share of a total number of enterprises, playing a significant role in creating gross domestic product and providing employment. In the European Union (EU), the SMEs in transportation and storage services sector comprised 5.09% (the EU average) of the total number of enterprises in 2014, respectively – 6.84% in Latvia; employed in average 6.17%, in Latvia – 9.44% of all private sector employees; produced an average of 6.22%, in Latvia – 11.47% of added value (SBA Fact Sheet. Latvia, 2015). In Latvia, the SMEs in transportation and storage services sector comprised the biggest share of all SMEs, employed more staff and generated higher added value in comparison with the EU average in 2014.

The financial indicators used for business performance evaluation in studies of the researchers (Fernandes *et al.*, 2006; Cardinaels, 2010) point towards their diversity.

The authors of the paper believe that, aimed at recognition and assessment of the significance and role of the financial indicators and intended for successful solution of the companies' financial management problems, the issue of development of a single financial indicators' evaluation system in the context of business performance evaluation arises.

The research is based on the analysis of the academic literature and research publications, assessment of the financial indicators used in the Latvia's institutions for evaluation of financial analysis of the enterprises, and the results of the experts' survey. The following general study methods are used in the research: analysis and synthesis of information, logical construction, monographic, expert survey method, data grouping, and graphical presentation methods.

The aim of the research – is to analyse the practice of business performance evaluation of the SMEs in transportation and storage services sector in Latvia.

In the result, the study of business performance measurement and management of the transportation and storage services sector’s SMEs is carried out and the financial indicators used to evaluate business performance of the transportation and storage services sector’s SMEs are analysed.

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## UNEMPLOYMENT AS A FACTOR INFLUENCING MENTAL WELL-BEING

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**Keywords:** unemployment, unemployed and employed women, students of re-qualification courses, personality profiles, MMPI test, cluster analysis

The transition from the socially planned economy to the market economy has created unemployment in Latvia, too. As a result a new social group of the unemployed has emerged. According to the data of the State Employment Agency of Latvia, as of 30 Jun 2016 there were 78 164 registered unemployed, which constituted 8,3% of the economically active citizens. The rate of unemployment was 5,0% in Riga, 18,0% in the districts of Latgale, 15,8% in the district of Rezekne, 11,9% in the district of Liepaja and 6,9% in the district of Ventspils (*Pārskats par bezdarba situāciju valstī*, 2016). This data points to the topicality of the issue in modern society.

A significant number of scientific endeavours have focused on the study of personality under the conditions of crisis at the time of social transformations. However, much of such research has been conducted in relatively stable and well-established market economies. Theoretical aspects of social psychology that pertain to social contexts prescribe clarification of the system of universal factors, which influence an individual under specific historical and cultural circumstances. Consequently, research that is particularly useful is the one that provides data on individual peculiarities under specific historical and cultural circumstances. In the context of Latvia it would translate into individual peculiarities under Latvian-specific historical and cultural circumstances that emerge as a reaction to a specific situation in the state. To develop an effective employment policy is hardly possible without consideration of the psychosocial state of the unemployed. Therefore, not only is the statement of individual peculiarities significant, but also the definition of typical regularities, which allows to choose the most effective forms of psychological assistance and support.

This paper addresses the results of the cluster analysis of the MMPI test profiles of the unemployed and employed women in order to construct the most typical profiles of the unemployed women and to define the most optimal directions of psychological assistance. Those personality profiles which were identified in the MMPI polling were classified using the methods of the cluster analysis. The participants of the study were 50 employed women and 298 unemployed women, most of whom were students of re-qualification courses at two educational institutions in Riga. The constructed personality profiles were grouped into 5 clusters. This paper provides characteristics for each cluster and offers recommendations for psychologists, pedagogues and other professionals who engage in re-qualification training of the unemployed or provide other services to the unemployed.

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## NON-FINANCIAL VALUE DRIVERS: CASE OF LATVIAN BANKS

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Non-financial performance is considered to be as much important, as financial results, in the value creation process. Non-financial value drivers involve company's reputation, customer satisfaction and loyalty, staff competence, employee satisfaction and turnover, and innovative potential (Sledzik, 2013; Larsen and Tan, 2015).

A large amount of studies were devoted to the investigation of the link between company's financial performance and corporate responsibility performance, trying to find out whether responsible behaviour contributes to the shareholder value (Allouche and Laroche, 2005; Lo and Sheu, 2007). The value in the banking industry, probably more than in other ones, is created by “consuming” of non-financial capital, since “banks rely predominantly on intellectual, human, and social and relationship capitals to create competitive advantage” (Larsen and Tan, 2015).

The goal of the current paper was to study the relationship between banks' value and non-financial performance indices.

Research period covered 2012-2015. TOP101 initiative was launched in 2005, but the statistics of non-financial bank performance indices is available mostly since 2012. Research sample was limited by the number of Latvian banks included into the list of most valuable Latvian companies in each particular year. In average, 50 per cent of operating banks were analyzed.

Selection of non-financial value factors was based on the relevant studies in banking (EABIS, 2009; GABV, 2012) and, in particular, in banking (Marie *et al.*, 2014; Ahmed *et al.*, 2015).

The list of non-financial performance drivers for this particular study is limited by the number of available indices, which can be used as proxies for the statistical data processing. The authors analyzed statistics provided by the Association of Latvian Commercial Banks (ALCB), results of the Latvian recruitment agency's “CV-online” survey “TOP employers, corporate governance scores included in TOP101 survey, reputation index and the results of the surveys “Top of Latvian favourite brands” and “Sustainability index”.

To achieve the research goal, the authors used expert survey method and statistical data processing, in particular, correlation analysis and multiple regression analysis.

The study is limited by the number of banks investigated, as well as by the number of non-financial performance indices used.

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## UNIFIED, LOW-COST ANALYSIS SCHEME FOR THE CYCLING SITUATION IN CITIES: THE CASE STUDY OF NABEREZHNYE CHELNY

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**Keywords:** cycling, modal split, sustainable transport

Increase of motorization rate provides to imbalance in the transport system: especially, it concerns urban areas. This issue concerns more or less each country regardless its location (Zhao, 2014). One way to redress the balance is a promotion to use other modes of transport (Sá *et al.*, 2015; Moeinaddini *et al.*, 2015). Bicycle is one of such suitable modes of transport. Development of cycling conditions is a possibility to influence on modal split and, therefore, to make positive impact on the whole transport system (Salonen, 2013; Scheepers *et al.*, 2014).

Successful collection and assessment of data about cycling conditions and infrastructure can help to determine cycling potential of a certain place as well as to achieve this potential by development and improvement of these conditions. To gather necessary information there are different sources approaches including administrative data, counting, observation, surveys, crowd-sourced data from social media (Big Data), etc. The most comprehensive methods among them is survey (Patterson *et al.*, 2014; Wegener, 2013).

The main disadvantage of survey data collection is its high cost. Trying to decide this issue, one-page questionnaire was created within the scope of the project “BICY- Cities and Regions for cycling”. This mobility survey includes an amount of questions concerning typical day trip, travel experience, attitude to bicycle and public transport as the main mode of transport, etc. All this information gives a possibility not only to assess cycling situation in the certain city, but additionally also to calculate a modal split and future modal change by scenarios (Schweizer *et al.*, 2012; Schweizer and Rupi, 2014; Spickermann *et al.*, 2014).

Besides theoretical and methodological backgrounds, this paper presents a case study research done in the city Naberezhnye Chelny (Russian Federation) and based on above-described survey.

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## ESTIMATION OF THE RELATIONSHIP BETWEEN THE PRODUCTS RELIABILITY, PERIOD OF THEIR WARRANTY SERVICE AND THE VALUE OF THE ENTERPRISE COST

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**Keywords:** cost structure, warranty servicing, warranty period, reliability level, probability of failure of the product, unit cost

Every company is fighting for the consumer under the circumstances of modern market economy. To attract and retain consumers of their products, companies develop and offer a huge range of additional features that make the produced product more attractive. These features include favourable terms and conditions of payment, flexible system of discounts for customers, as well as a system of products warranty.

Both warranty and reliability have received a lot of attention over the last fifty years (Murthi, 2008).

The area of warranty has been studied by researchers from many different areas such as economic, engineering, statistics and more. A number of techniques have been used as a method in solving warranty problem. In past few years, there has been an increased used of statistical methods instead of soft computing methods in warranty related applications. However, soft computing methods have been used by many researchers in the other research area which can provide some feasible solutions for the complex real-world problems (Majid *et al.*, 2013).

Thus, warranty services and repairs is one of the most important resource-efficient activities provided by structure of modern designed innovative products. In all cases, the manufacturer bears full responsibility for the process and the results of warranty services; value and quality of these services have the greatest importance for the consumers.

Higher reliability is expected to reduce the cost of warranty returns, but at the same time to drive up the cost of product development. Thus an optimal solution is possible by finding a target reliability corresponding to the lowest value of the total expected life cycle cost (Kleyner *et al.*, 2004).

The base warranty is integral to the sale and as such factored into the sale price and the customer does not pay anything extra. Extended warranties are optional which customers purchase by paying an extra amount. These are offered by several parties – manufacturers, retailers and independent agencies such as insurance companies etc.

There are several different notions of warranty costs. These include warranty cost per unit, warranty cost over some interval (for example, product life cycle) and warranty costs per unit time (warranty cost rate). As mentioned earlier, the warranty costs depend on product reliability and the product usage.

For products with longer lifetimes, the total warranty cost is uncertain over longer period of time due to the uncertainties of lifetime and the costs of servicing claims. If the lifetime is more than one year, the future cost will be affected by increased labour cost, inflation and devaluation of money over time (Rahman and Chattopadhyay, 2015).

However, the most important issue for the manufacturer offering the product warranty is increasing costs of the warranty implementation, to the forefront come issues related to, as well as the determination of the warranty period at which the maintenance costs are economically viable.

The only alternative to the failed product items complete substitution in the connection with the considered case is a repair (restoration).

Manufacturers offer many types of warranties to promote their products. Thus, warranties have become an important promotional tool for manufacturers. Warranties also generally limit the manufacturer's liability for out-of-warranty product failure. Although warranties are used by manufacturers as a competitive strategy to boost their market share, profitability and image, they are by no means cheap.

Warranties cost manufacturers a substantial amount of money. From a manufacturer's perspective, the cost of a warranty program must be estimated precisely and its effect on the firm's profitability must be studied (Murthi, 2008).

Taking into consideration the above-mentioned material it is possible to draw the conclusion that the enterprise can achieve the minimal costs of manufacturing and warranty serving, but at the same time the level of the reliability of manufactures product does not meet the necessary requirements; it is in the area of the inadmissibly low values. Unsatisfactory quality of the warranty service can cause not only the loss of competitiveness, but also influence the transportation safety if it is a transportation company.

As a result, it is possible to consider that the quality of the warranty service, i.e. the probability of the non-failure operation is one of the most significant factors determining the enterprise costs under the conditions of the market economy.

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## RELATIONS BETWEEN WELLBEING AND TRANSPORT INFRASTRUCTURE OF THE COUNTRY

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**Keywords:** wellbeing, transport infrastructure, level of poverty, disposable income of households, statistics, correlations

The concept of wellbeing is rather difficult for perception since it cannot be expressed by just one definition. It usually gives quite broad illustration of the standard of living of the population and comprises both concepts measuring the subjective satisfaction of people (it concerns happiness, relations within families and with friends, with colleagues etc.) and objective indicators

In any case, wellbeing reflects the quality of life of the country population. The indicator is not the static one, vice versa it is highly dynamic and changes together with the ideas and perception the people have about their possibility to fulfil the goals of their life, both personal and social. (Statham and Chase, 2010; Rees *et al.*, 2009). Many researchers consider the indicators of health as the main factors of wellbeing; there exist special Boards, dividing duties and responsibilities on following the issues of health and wellbeing,

Some measures, such as the New Economics Foundation's Happy Planet Index place particular emphasis on environmental impact and sustainability (Happy Planet Index). Nevertheless, it is impossible to speak about quality of human life without certain economic indicators which create the material basis for happy and long life and accomplishing the goals in this life.

At the same time, the efficiency of national economy and economic growth as well as sustainable development of industries and entire regions are determined to a great extent by the transport sustainable functioning. Moreover, the international economic activities are determined by the rate of transport infrastructure development.

The goal of this research is to find out the relations between wellbeing of the population and the level of transport infrastructure development.

The research reveals the importance of transport infrastructure for the economic development of the country, considers wellbeing as a complex concept, discovers the interrelations of transport infrastructure and indicators of wellbeing of the population and compares the situation with transport infrastructure in the Baltic States (Estonia, Latvia, Lithuania).

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## ISSUES OF TAX COLLECTION FROM BIOENERGY IN LATVIA

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**Keywords:** tax, bioenergy, Latvia, government income

Sustainable development requires energy source stability and environmental maintenance. Over-exploitation and the intensive use of nonrenewable fossil fuels thus eventually hamper the development of human society. Bioenergy is one solution to this problem. This study formulates a the economic and environmental effects of bioenergy development in Latvia. The result indicates that the farmers' revenue primarily originates from energy sales, government subsidies and emission reduction. An inappropriate subsidy amount will result in inefficient resource allocation; in addition, the marginal benefit from bioenergy production is fairly small. The result also shows that the joint production of bio-electricity and ethanol could be a better choice if climate change mitigation is considered.

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## INTERTEMPORAL EFFECTS OF THE PUBLIC DEBT OF LATVIA

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**Keywords:** public finances, public debt, intertemporal effect, generational accounting

The public debt of Latvia at the beginning of 2016 amounted to 8.384 billion EUR, which corresponds to 33% of GDP. In the EU countries the average share of public debt exceeds 80% of GDP, compared with the same indicator of the public debt of Latvia formally not serious. However if we consider the public debt structure and schedule of future payments, the estimation will be slightly different. In the government debt structure of Latvia's foreign debt is 83% and if the 2016 payments should amount to 400 million EUR, in 2020 - 1.3 billion EUR and in 2021 - 1.4 billion EUR (Valsts kase, 2016). Naturally to make such payments due to the current budget is impossible and would require new loans.

The concept of relative safety for the economy of the budget deficit through the issuance of debt and the increase in public debt has been and remains the predominant both in economic theory and in modern economic policy. The main argument in favor of debt financing is to reduce the risk of inflation. As for the need to pay for the increasing debt, it is a widespread view according to which the state will always be able to repay previously issued obligations by issuing new debt and eliminate the threat of default (Brummerhof, 2002).

However the unstable state of the financial markets in recent years and the rapid growth of public debt levels in most industrialized countries contribute to increasing skepticism about the ability to assess the debt without serious consequences for the economy to solve the problem of public finances.

In assessing the impact of the growth of public debt the most important for the country is the intertemporal aspect of the problem, namely, whether and to what extent the public financial burden be shared by future generations. The extent of the impact of public debt on future generations who will have to implement the return of credits depends on the sources of the public debt. If the financing of public expenditure at the expense of domestic debt, then there is the movement of resources from the private sector and government loans do not have an impact on the burden of future generations. Future generations have macroeconomically balanced the requirements and obligations. Payment of interest and repayment of loans are the transfer of property rights between the economic entities groups. If the taking of loans made abroad, the future generation will be obliged to pay the sum of overseas loan repayment and interest that would reduce the resources used within the country.

Future taxpayers are responsible for servicing the public debt, and this requires the development of Generational Accounting in Latvia.

The concept of Generational Accounting is designed to show what level of debt falls on the population now and in the future (Auerbach *et al.*, 1994)

Development in recent years Generational Accounting in a number of industrialized countries shows the importance of this issue (Hagist *et al.*, 2009).

Using Generational Accounting contributes to the development of tools for the systematic analysis of the intertemporal effects impact of modern financial decisions on the economic situation of the population in the future.

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## EVALUATING THE INTERRELATIONSHIP BETWEEN ACTIONS OF LATVIAN COMMERCIAL BANKS AND LATVIAN ECONOMIC GROWTH

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**Keywords:** Latvian commercial banks, operating results, economic development, regression model

The global financial crisis of 2008 – 2010 and the post – crisis period highlighted the significant impact of commercial banks on real GDP growth in Latvia. A sharp contraction in credit that Latvia experienced as external financing became scarce had shown that banks can not only promote growth, but also endanger it. Safeguarding the stability of the financial system and minimizing the risks of negative spillovers from the banking sector to the rest of the economy is the key objective of bank supervision. Bank supervision has recently been strengthened in the euro area with the introduction of the Single Supervisory Mechanism, which covers Latvian banks as well.

However, even in the aftermath of the Single Supervisory Mechanism, Latvian commercial banks continue to struggle with problems and changes in the global banking industry that affect their operating results, which, in turn, can affect economic growth. On the other hand, real GDP growth can affect the profitability and stability of the banking industry. Thus the interrelationship between commercial banks' operations and economic growth in Latvia is a highly relevant topic, even though the literature on it has been scarce.

This paper aims to present the results of the empirical study, which evaluated the influence of Latvian commercial banks' operations on the economy, based on economic theory and the analysis of banks' operating results and economic growth trends. The evaluation yielded recommendations on how to improve banks' operating results and mitigate attendant risks. The study aimed to establish whether there is an interrelationship between growth and changes of commercial banks' indicators.

The existence of this interrelationship was tested using Granger causality and Johansen cointegration tests. Granger causality test is used to establish whether one variable can be used to forecast another. Johansen cointegration test is used to test whether a linear combination of several variables is stationary, that is whether there is a stable relationship between them. The analysis was based on quarterly data from 2001 to 2015. The study reviewed several indicators for banking developments to establish their relevance for GDP growth: credit to non-banks, non-bank deposits and bank profits or losses.

Results suggest that the existence of cointegrating relationship between GDP growth and bank profits or losses cannot be rejected; hence that is the most relevant variable. There are several underlying mechanisms for this relationship. First, Latvian banks are significant taxpayers of corporate income taxes. They also employ a significant number of people, who pay personal income taxes and social security contributions. Second, Latvian banks have a significant nonresident client base, thus their services are part of services' exports. Third, banks in Latvia, as well as elsewhere, play a crucial role in resource allocation – they provide credit to facilitate productive investment, which increases both potential and actual GDP growth.





## Session 11

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# Education

## MANAGEMENT OF A TECHNICAL UNIVERSITY IN THE CONTEXT OF PREPARING STUDENTS FOR THE 21<sup>ST</sup> CENTURY CAREERS IN SCIENCE AND TECHNOLOGY

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**Keywords:** Technical university, 21<sup>st</sup> century skills, educational management, competitive strategy

Today, the delivery of educational services is accomplished in a diversity of ways due to the rules dictated by the ever-evolving global environment. As the global environment has changed drastically over the last decades and has become more uncertain, the prevailing management approaches do not seem to be well-suited for contemporary universities. Both public and private universities are now pressed to perform their traditional functions (teaching and research) more efficiently. The expectations of students have changed to a large extent, which makes higher education institutions become more flexible for meeting the expectations of new student populations. Employers and policy-makers call for developing the 21<sup>st</sup> century skills such as critical and creative thinking, problem-solving and team-work skills, using technology for analysing and synthesizing information for application in the knowledge-based economy. Universities have to compete for attracting international students, staff and research funds in the agenda of the cross-border higher education.

From a managerial standpoint, higher education institutions must find the most capable methods to balance their position in the international education market in terms of internal strengths and weaknesses against external threats and opportunities. Senior managers of a contemporary technical university have to re-examine their educational strategies aimed at achieving academic and research excellence, which requires flexible and responsive forms of management that are more inclusive of academic and research aspects in the decision-making process.

This paper considers the implications for managers and academics, as key stakeholders of a higher education institution, in the highly globalized modern environment. The paper explores a few central issues faced by the management of a technical university in the framework of developing a competitive strategy with due account for the needs of new student populations, as well as employers and policy-makers.

## INTEGRATING VIRTUAL COMMISSIONING BASED ON HIGH LEVEL EMULATION INTO LOGISTICS EDUCATION

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**Keywords:** Virtual Commissioning, High Level Emulation, Simulation, Logistics Education, Material Flow Laboratory, Process Design

With a growing number of variants and higher requirements towards service quality and schedule flexibility, the present approaches for logistics planning and operation are challenged. The increasing complexity is showing the weaknesses of classical centralized material flow controls and is impeding the development of these control systems (Bauernhansel *et al.*, 2014).

Computer simulation is a widely accepted method to face the new complexity during the planning process and within operations. Today’s material flow simulation software is enabling the user to easily model complex logistics systems implying great advantages in various areas of usage (Schenk, 2014).

As a special case of application, simulation is allowing the virtual commissioning of controls by emulating the physical components of a system. Virtual commissioning shortens the launch time for control systems, improves the control software quality by facilitating extended test runs and debugging, and can be used for training purposes (Günthner and Tenerowicz-Wirth, 2012). These qualities are highly welcome in the context of growing complexity in the development of material flow controls.

The usage in industry differs on the separate levels of the automation hierarchy. While it is very common on the PLC level, where sensors and actuators are playing the main role, Zhang, Le, Johnston, Nahavandi, and Creighton (2012) identified “a gap [...] between the low level PLC emulation and the high level scenario-based if-then strategic analysis”. Since examples (Gutenschwager *et al.*, 2000; Boer and Saanen, 2008; Meyer *et al.*, 2012) showed that it also brings huge advantages when used during the development of higher level controls, such as material flow controls or warehouse management systems, the concept should be included into logistics education.

This paper describes the integration of a high-level emulation based virtual commissioning tool into the LogCentre Project at the German-Kazakh University in Almaty. This project is offering educational services to the DKU student and logistics related research to the Kazakh industry. Beside classical simulation classes, a material flow laboratory with RFID is provided to the students. The main purpose of the laboratory is to offer the chance to design, implement and verify logistics processes. Students should be able to learn how to program material flow controls in different aspiration levels from the PLC up to the process control. That means, that high-level virtual commissioning is not only applicable once during the system installation, but also during the everyday teaching.

The implemented emulation model was created with ExtendSim9, which is also used in the LogCentre’s simulation courses. It emulates conveying technology, PLC, RFID-readers and the respective input/output behaviour towards the process control. Mimicking the physical laboratory, the emulation needs human interaction. User inputs into ExtendSim can be done during the simulation run with the help of form fields and buttons.

The virtual commissioning tool consists of elements of the standard discrete event simulation library. The material flow control application is connected using the COM-interface which is embedded in the used simulator. Customized 2D-animation was added to visualize all necessary information for the verification of the process sequence programmed.

The integration of the virtual commissioning tool into the learning environment results not only in an improvement of the teaching itself (simplified validation of the developed process logic, higher laboratory capacity as most of the testing can be done virtually, protection of the laboratory from physical damage due to improper programming) but it also deepens the students understanding of virtual commissioning methods.

### **Acknowledgements**

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## WHAT MOTIVATES A LEARNER MANAGER OF A LOGISTIC COMPANY TO ACHIEVE FINANCIAL LITERACY?

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**Keywords:** financial knowledge, learner manager, achievement motivation, correlation analysis

As long as there exists discussion in the academic sphere about the essence of finance regarding their being ‘art’ or ‘science’, the managers and entrepreneurs, especially the beginners, feel necessity of real basic knowledge of the financial management. Without understanding of basic financial concepts a manager is not well equipped to make decisions related to financial management. Any mistake of management decision making results in the loss of money; this is particularly ‘sensitively’ at the start-up stage of the newly born enterprise. Financial knowledge helps people feel more committed and involved in an organization. In our opinion, a manager does better when he understands how financial success is measured and how he has an impact on the company’s performance. In this case we speak about of a manager’s financial literacy.

In modern financial management theory managerial and behavioural functions of finance are dominated. It strengthens the role of the financial management in the education process of a modern manager. How shall we assess ‘the weight’ of the necessary knowledge in finance and of financial skills in management education? We do believe that the volume and depth of the financial knowledge required for manager are determined by different factors. Among these factors there can be pointed out the business size, its functionality, the degree of a manager’s responsibility, the corporate culture and business environment. But there is another side of the management education process – how strong is the eagerness of the young managers to acquire knowledge and develop the skills of professional competence.

The given paper states the results of the research undertaken by the authors to reveal the influence of the personal qualities of underground students on the efficiency of mastering the financial disciplines. In the authors’ research there have taken part 64 students at the age of 18–23 learning under the study programs “Transport and Business Logistics” and “Management of transport organizations” of the Transport and Telecommunication Institute. The role of achievement motivation and its components has been determined in the process of research; there also have been determined the role of intellectual capabilities of students-prospect leaders of transportation and logistics companies while they are studying at the university at the programmes of higher professional education and mastering the financial courses and achieving the financial literacy.

To obtain the answer to the question whether there is any connection between the achievement motivation and mastering the financial literacy, there have been used such research methods as Achievement Motivation Inventory (AMI), and Raven's Progressive Matrices (SPM-C), and the learning outcomes of the educational courses have been analysed. AMI gives assessment of 17 dimensions of work related the Achievement Motivation. The results of the research witness that striving for achievements is one of the main motivation factors to achieve of financial literacy and to develop skills in financial management.

## CONDUCTING RESEARCH FOR THE LEARN IT INTERNATIONAL PROJECT: EDUCATIONAL AND MANAGERIAL ASPECTS

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**Keywords:** higher education, LEARN IT, cross-disciplinary research project, sustainable project performance

LEARN IT (*Learning with ICT use*) project is implemented under the ERASMUS+ programme by the consortium established by three higher education institutions: University of Economics and Innovation (Poland), Klaipeda State College (Lithuania), Transport and Telecommunication Institute (Latvia). The main results of the implementation of LEARN IT are supposed to be the properly equipped Learning Lab and original software for mobile devices. The innovative solution proposed in the framework of LEARN IT is intended for improving efficiency of the learning process by stimulating students' level of concentration.

The challenges faced by educators in the process of implementing the project are related to the complex nature of a contemporary university. LEARN IT is a cross-disciplinary research project involving people of different professions and positions, heterogeneous organizational resources, various managerial practices and educational tools.

In the framework of LEARN IT, different tools for testing students' cognitive abilities, their motivation, and their level of mathematical skills are used. Psychological tests are applied for measuring cognitive abilities and motivation of students; some of them are included in the Vienna Test System: DAUF test (aimed at assessment of long-term selective attention and concentration and of general performance and commitment); NVLT (aimed at assessment of non-verbal learning); AHA (measures respondents' aspiration level and frustration tolerance). Two more psychological tests were also chosen for the project's purposes: LMI (the Achievement Motivation Inventory) developed for measuring achievement motivation, and SPM (Raven's Standard Progressive Matrices) developed for use in fundamental research into the genetic and environmental determinants of "intelligence" Mathematical tests were prepared together by researchers from partner institutions taking into account the program of the Khan Academy and instructions of European Commission on assessing learners' key competences.

The LEARN IT project execution occurs in different functional project areas. In the process, project managers employ a variety of resources aimed at achieving sustainable project performance. In the agenda of the LEARN IT implementation, special emphasis is to be given to generating and sustaining excellence of its technological, educational and research constituents, which, in turn, is based on improving the quality of university services and facilities and attracting qualified academic and research staff.

The purpose of the paper is to discuss key educational and managerial aspects related to conducting research for a cross-disciplinary international project in a higher education institution.

# THE RELATIONSHIP BETWEEN ENGINEERING CREATIVITY AND PERSONALITY IN EDUCATIONAL ENGINEERING PROGRAMS: A META-ANALYSIS STUDY

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**Keywords:** creativity, engineering, personality, education, meta-analysis, correlation

Creativity enhances analytical skills and yields innovations. As a result, mastering and implementing creative solutions is amongst key targets of engineering professionals who are compelled to nurture creativity due to intense competition on the marketplace laden with products of relatively short lifespan (Belskia *et al.*, 2016). Therefore, the development of creativity should be an essential aim in contemporary engineering education, yet engineering programs are often not designed to develop creative skills (Tekica *et al.*, 2015). Transport and telecommunications are the fields that train engineers and therefore the development of engineering creativity should be aspirations of such programs, too. To be able to design adequate training programs, the relationship between traits of engineering creativity, such as of products, processes, contexts and personality, should be established.

Using a meta-analysis method, this paper studies the relationship between two of these concepts – the creative engineering product and creative engineering personality in comparison to the epitome of creativity – arts, which have recently been included into the SMET program, thus forming SMEAT - science, technology, engineering, arts and maths (Maddena *et al.*, 2013). This study largely draws on the meta-analysis of Feist (1998), who studied the relationship between scientific and artistic creativity and personality and who found that the largest effect on creativity was exerted by the personality traits of openness to experience, conscientiousness, self-acceptance, hostility and impulsivity. Other personality traits, such as autonomy, introversion, norm-doubting, self-confidence, drive, ambition and dominance, had a lesser impact. The meta-analysis that was conducted for this paper indicated that not all of Feist's traits were relevant to engineering creativity to the same degree, which could be attributed to the professional context of engineers. Overall, the results of this paper support the view that creativity is multifaceted not only in its traits, products, processes, contexts but also functions. Therefore, educational aims for the development of creativity should be multidimensional and tailored for the needs of particular programs and professions.

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## ADULT STUDENTS' PROBLEMS IN THE DISTANCE LEARNING

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**Keywords:** adult students, distance learning, psychological problems

The mature aged students have consistently been a major sector in all universities, especially for correspondence and distance learning. Problems of distance learning devoted quite a lot in pedagogical literature, also a lot of researches has been devoted to the rules of training adults. However, such contingent as mature students is not researched fully in relation to the distance education system.

The article is devoted to research whose purpose is (using the experience of Transport and Telecommunication Institute) to identify and explore the range of problems commonly encountered by mature students studying remotely, outline the factors, which cause a feeling of anxiety in adult learners and can deter adult participation in distance education, and suggest some methods to cope with this anxiety and to optimise the learning process.

The study involved students of the first and second-year undergraduate studying remotely or by correspondence, working (full or part-time), married and unmarried. Participants' age ranged from 21 to 50.

The basic methods in the study were interviews, survey of experts and sociological observation.

The study found that the challenges and obstacles faced by mature students studying remotely are divided into several different categories. Particular attention is drawn to the group of problems that is related to the psychological experiences of students and includes problems associated with anxiety about the process of study and learning outcomes.

Different causes call the anxiety of adult students, including:

- Lack of experience in distance education. This circumstance gives rise to doubts in their abilities, fear to manifest incompetence in the new conditions of online learning, especially in technical matters;
- Some misconception about the university environment as youth community, which would be difficult or even impossible to fit an adult;
- Doubt in a right to finance expenses for their own education (to the detriment of the family);
- Lack of support in the family or by the employer, as well as a lack of understanding or lack of support from peers;
- The presence of life, social and professional experience and the achieved social status. Due to these circumstances the mature students evaluate their mistakes and errors more personal (and painful);
- The sense of futility and irrelevance of their training; etc.

Thus, may be stated that, despite the promises and the obvious advantages of distance learning for people involved family and career, there are problems that need to be addressed. Each of these problems has an effect on the overall quality of distance learning as the product.



## Session 12

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**Invited Session:  
Problems of scheduling, routing,  
identification, safety and  
effective data delivering in  
interconnected systems**

## SCHEDULING AND ROUTING ALGORITHMS FOR RAIL FREIGHT TRANSPORTATION

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**Keywords:** algorithm, scheduling, optimization, rail transportation

Fast-growing industry requires efficient delivery of a huge amount of stuff. Transportation time is often very short and it is not easy to meet a deadline. Transportation can be accomplished by the road transportation. Unfortunately, there is a high risk of traffic jams that generates losses. However, on some roads there is weight limits imposed on vehicles so it enforces selection of longer routes or use of greater number of trucks. Transportation speed on is disappointing. All these factors make road transportation uneconomic and elusive. Competitive approach employs a rail transport. Proper planning may cause lack of congestion on the railway line, it allows to carry huge amount of stuff at once, allows to shorten delivery time and it is more safe than road transport.

The freight scheduling problem is one of the most difficult problems belonging to the family of transportation problems. Due to its complexity it poses a big challenge for modern Operational Research studies thus it is in a high demand. It consists of three subproblems:

1. train scheduling problem(choosing proper moment for train departure along its route),
2. locomotive assignment problem (assigning locomotives to trains) and
3. locomotive team assignment problem (assigning teams to locomotives in an optimal way).

Planning train schedules and routes imposes execution of algorithms on quite big data sets. For instance current polish rail network consists of 999 railway lines, 588 station building and more than 2500 motor engines.

However, in order to obtain usable solution that can be applied in the real world some constraints should be considered. Certain distance should be kept between trains; there can be some parts of the rail track where trains may move in both directions but not at the same time, etc. It can be difficult to find even a feasible solution since chosen train paths may mutually exclude themselves. Moreover, there is a need to carry out maintenance tasks, so trains cannot be used continuously for transportation purposes.

A difficulty in finding good solutions increases when it comes to rail networks with a high traffic density. Furthermore, there are many expectations related to the transportation regarding safety, speed, capacity and reliability. All mentioned factors force the use of sophisticated algorithms to solve scheduling and routing problems in a reasonable time.

In the paper we propose an exact algorithm for determining the fastest route for single additional train. The problem is similar to the problem of finding shortest path from fixed start node to all other nodes in weighted graph, which is solved in polynomial time by Dijkstra's algorithm. However, due to significant differences between problems, we propose a modification of Dijkstra algorithm adapted to a problem of finding fastest route. We also present a case study based on real data taken from Polish railways (Polish State Railways, Inc.).

## SOFTCOMPUTING METHODS TO IMPROVE THE SAFETY OF TRANSPORT SYSTEMS

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**Keywords:** discrete transport system, road monitoring, vehicle recognition, vehicle dispatching, AR, AV, ANPR, MMR

It is not easy to indicate the beginning of thinking about the safety in cars and traffic. The modern classification of safety and its understanding has appeared in the 60's of the twentieth century. The term active safety refers to the systems that help avoid accidents – in this context simple systems such as brakes or steering allow driver to drive correctly and to avoid an accident. ABS (Anti Blocking System) is much more complicated system working with brakes and allows driver to brake safe in the specific road conditions (e.g. a slippery road). The second widely used term is passive safety which is connected with the set of systems reducing the effects of an accident – airbag or seat belts start working in accident. Last few years showed the trend in automotive industry to develop advanced active safety systems such as the ESP (Electronic Stability Program), the LineAlert or the OpelEye is growing. The future of safety systems is rather connected with developing solutions that allow avoiding accidents many ways. However the basic problem is to create hardware working faultless in the specific automotive environment with overloading, high temperature or vibration.

Despite the fact that intelligent computing methods are used in many fields of industry and science (e.g. an aviation industry, chemistry or climatic models) their usage in the automotive industry is still marginal especially in the safety solutions. Of course it would be correct if e.g. the ESP will be called "intelligent system" but its "intelligence" basis on the effects of its work not on the way it works (ESP works using many sensors and special algorithms but it does not use e.g. neural networks or fuzzy logic). The automotive companies have a few solutions which can be described as the intelligent ones. Opel has its the OpelEye system which recognises road signs and shows the effects of its work as the road signs icons on the screen on the dashboard. This system increases safety from definition. BMW has system using an infra-red band camera. System can recognise not illuminated pedestrian or biker and show his shape on the screen on the dashboard. Both of these systems use the intelligent computational methods. However the observations of the automotive market give the question why the number of intelligent safety systems is so small. Nevertheless automotive companies develop other intelligent systems not connected with the safety from definition. An example is given by Fiat and Microsoft. Those two companies developed "Blue & Me" system which allows driver to communicate with the car using voice. It is not obvious but e.g. answering the mobile phone using voice ("Blue & Me" uses Bluetooth to communicate with the mobile phone) can be considered as increasing safety.

The paper presents the usage of the intelligent processing methods in vehicles to increase an active safety without any interference with a driving process. We are taking into account three aspects. The main goal of the first one is overtaking driver's reactions. The driver analyses pictures in front of the vehicle and tries to decide which kind of reaction is suitable for a specific road event. The situation when driver's reaction is too slow happens very often. The system must be faster than human being in analysing pictures in front of the vehicle and recognising road events. This system should inform driver about each kind of recognised event. The information about recognition should be transmitted as a voice or as a picture message. The type

of message is connected with the specific conditions. The system is going to be an autonomic solution without any connection to any kind of database or other remote resource and should be able to learn in its whole life cycle. Each "turning on" should start learning procedure from patterns collected previously.

The second aspect - the monitoring devices are able to use automatic number plate recognition (*ANPR*) techniques to capture and store the various parameters for vehicles recognised in automatic way by the video detection techniques. The registration numbers, the make and model (*MMR*) of vehicles are recognised and stored in the database. The collected parameters are the basis for analysing real travel time problems related to the trucks operating with the commodities among the nodes of the discussed transport system. We try to observe the changes during the consecutive days of a week, as well as for much longer time-horizons, taking into account the traffic jam problems and other extraordinary situations like crashes, or extremely bad weather conditions, which can have significant influence on the typical time travel. The next step is to generalize the results of travel time analysis into the travel time model. Such a model, based on the real data taken from the road monitoring system, can be a very important part in a larger simulator for discrete transport systems, as its behaviour very closely resembles the real system.

The final safety aspect is based on intelligent dispatching method. We fight for better – more sensible - vehicle usage, faster and more accurate reactions in case of extraordinary situations on the road as well as the best return to stable state after the general crash of the transportation system.

The future of *AR* solutions for an automotive industry is strictly connected with head-up displays. They need to be cheaper and easier to obtain. Compilation of: object recognition systems (pedestrian, road signs, buildings and institutions), *GPS* based navigation, set of sensors monitoring vehicle environment, adaptive cruise control systems, simple sensors such as park sensors in connection with a head-up display and sound device can increase traffic safety, give the chance to drive the easiest way and does not eliminate a driver. The future of *AV* is to collect as much data as possible to cover the biggest number of road traffic scenarios. Based on gathered data we analysed the travel time. We are able to find the travel time distribution of monitored road segments for different days within required time-interval. We also generalize the results of travel time analysis into travel time model. Our model can be incorporated into complex simulators for discrete transport systems. Thanks to the real-life data methodology used for its creation, the reliability and functional analysis in these simulators can be improved, yielding more realistic and precise simulation results. This is why the proposed solution may become the essential tool for owners and administrators of transportation systems. The solution presented here can be used as a practical tool for improving vehicle maintenance and transportation system logistics, allowing for better fleet usage, fuel savings, and reduction of  $\text{CO}_2$  emission.

## AN EFFICIENT DATA DELIVERY TO DATA GRID

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**Keywords:** data grid, caching, initial load methods, performance

The most important element in any organization is the data collected each day. Working with data and accessing various type of information is important factor of day to day work activities. In many enterprises data is spread across many different databases, what causes difficulties to access them quickly. Problem can be solved by *implementing in memory data grid (IMDG)* (Colmer, 2011). *In memory data grid* is a data structure that entirely exists in random access memory (RAM) and is spread across many servers to provide high availability and higher capacity. As the data resides entirely in memory, access to it is much faster than to classic data stored on mass storage media such as hard disks.

Oracle Coherence is the market leader in data grids solution (Gualtieri, 2015). Coherence is a cluster product that allows to build distributed systems on many physical servers, giving possibilities to store data and process it in RAM. Coherence as *in memory data grid* can be used as additional tier in n-tier architecture. It could work as *read-only cache* tier storing data from *data tier* and provides it to *logic tier* (Waehner, 2014). Problem in this architecture is a method to replicate data from source databases to data grid. Process of data delivery consists of two sub-processes:

- initial load,
- change synchronization.

Initial load is a process moving all data from source table to data grid. It provides initial consistency between source data and data grid. Initial load is very heavy process for both database and data grid because its moving large amount of data. Change synchronization process allows to replicate from source database to data grid all SQL DML.

The aim of the paper is to describe and compare performance of initial load methods. Oracle recommends to use Oracle GoldenGate product to synchronize data from source databases to Coherence. GoldenGate provides very effective change synchronization mechanism based on transaction log in database. It allows to replicate changes from source database to data grid within seconds. From the other hand initial load mode is not very effective and custom adapter implemented in Java could perform the task much faster as GoldenGate. Custom adapter works with API that Coherence is providing. As Coherence is Java product, custom adapter have also been implemented in Java.

For the purposes of testing initial load performance dedicated test environment have been prepared. Data were moved from source database to data grid using GoldenGate and custom adapter. During the tests duration of entire process, number of processed records and storage utilization has been compared. Tests were carried out on samples differing in the number of records.

The result shows that custom adapter provide better performance and could perform initial load 7 times faster than GoldenGate. Adapter does not utilize storage and batter works as multithread tool. From the other hand GoldenGate is universal tool and do not require additional development. It provides many interfaces to databases and configuration is very easy to perform.

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## USING MEMORY RESOURCES IN FPGA IMPLEMENTATIONS OF BLAKE HASH ALGORITHM

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**Keywords:** FPGA, implementation efficiency, resource utilization, block RAM, loop unrolling

Malfunctions caused by security violations in operation of contemporary IT systems are so common and frequent that in present dependability analysis they must be treated in the same way as traditional reliability theory considered “classic” failures. For this reason to improve overall system reliability today it is necessary to apply appropriate cryptographic methods. In this paper we deal with one class of such methods which are based on so called hash functions, considering one specific method – the BLAKE algorithm.

Even though BLAKE (Aumasson *et al.*, 2010) adopts the rules of in-round processing of Salsa20 cipher (Bernstein, 2008), it introduces significantly different distribution of the message bits among the rounds. In Salsa20 and in majority of other hash functions (including SHA-3 winner KECCAK) the message bits are routed only to the input to the first cipher round in parallel with other data like salt, counter or nonce, forming the initial value of the state. That is, the message bits enter only beginning of the round cascade and are not propagated to each round separately. In BLAKE the message words are sent to each instance of so called  $G_i$  function – an elementary building block of the round – which considerably complicates organization of the hardware, increases the overall size of the design and impairs its performance.

In this paper we propose one viable solution to address this problem: application of memory modules which repetitively duplicate storage of the message words and provide them individually to every unit computing the  $G_i$  function. For this purpose we use block RAM units which supplement the programmable array in contemporary FPGA devices and we show that their dual port functionality fits perfectly such a task allowing to reduce by half the overall number of required units.

The idea is tested on 4 possible organizations of the cipher which were introduced and verified in our previous work (Sugier, 2016): the standard iterative one (which requires addition of 8 RAM blocks) and three high-speed loop-unrolled organizations with 2, 4 and 5 rounds instantiated in hardware (16, 32 and 40 extra blocks). Results found after their implementation in a popular Spartan-3 device form Xilinx (2009) shows that the proposed modification remarkably enhanced size of all the architectures: on average, occupation of the FPGA array is reduced by 52% in slices and by 50% in LUT elements which only illustrates what kind of burden in hardware was introduced by the distribution of the message bits among the rounds.

Improvements in performance, while not so spectacular, are also significant: the overall minimum clock period is shortened by 13% while other parameters shows that implementation and routing of the design becomes also more robust: reductions are by 11% in levels of logic and 6% in the routing part of the longest propagation path, and 19% in the average fanout of non-clock nets. What should be stressed the improvements are nearly constant and uniform among all the tested architectures regardless their size: the progress observed in the small x1 iterative organization is proportionally effective also in case of the largest, loop-unrolled x5 design.

The final issue remains whether these improvements compensate the extra cost of memory blocks added to the design. Although storing the message requires only 512b of RAM, the blocks available in contemporary devices are 16kb large so in the proposed application

merely 1/32 of their potential capacity is used (conditions of concurrent distribution of message words to the  $G_i$  units do not permit to optimize this usage). Nevertheless, it is common in the engineering practice that the whole design does not use all resources of the selected FPGA device and in such cases, if there remain some free memory blocks in the chip, using such "leftovers" for improvements in BLAKE implementation is definitely an option worth consideration.

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## PARAMETER IDENTIFICATION OF INTERCONNECTED NONLINEAR DYNAMIC SYSTEMS

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**Keywords:** Hammerstein system, Wiener system, system identification, least squares, instrumental variables

The purpose of system identification is to build the model, which describes relation between the input and output processes, using the prior knowledge of the system characteristics (e.g. laws of physics) and the measurement data. Adequate models allow for system simulation, design of optimal decision and control, fault detection and forecasting of system behavior. It is often of crucial meaning from the economical point of view. Correct decisions made in the system input allow to save time, energy and money.

System can be described with the use of block-oriented model i.e. Hammerstein and/or Wiener model. A concept of block-oriented systems, which is commonly accepted in the literature, is derived from the assumption that a real nonlinear dynamic plant can be successfully approximated by interconnections of simple blocks – nonlinear static elements and linear dynamic ones.

In the paper we consider the problem of identification of large-scale interconnected systems. Accurate models of complex nets are needed especially for optimal control in production and transportation systems. The specifics lay in the fact that individual elements cannot be disconnected and excited by arbitrary input processes for identification purposes. Moreover, structural interactions cause correlations between interaction signals. In particular, any output random disturbances can be transferred into the other inputs. It leads to cross-correlation problems, very difficult from the effective modelling point of view. First attempts made in 1980's were limited to static linear blocks, and in practice the results were rather devoted to linear dynamic systems working in steady state. In this paper we generalize the approach for components, which are both dynamic and nonlinear. All blocks are represented by two-channel Hammerstein systems. The least squares estimate is applied to identify unknown parameters of a system. The parameters of particular elements are obtained in singular value decomposition procedure. The algorithm as a whole is illustrated in simple simulation example.

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## SIMULATION OF GROUND VEHICLES MOVEMENT ON THE AERODROME

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**Keywords:** simulation; ground handling vehicles; aerodrome; optimization; modelling

One of the major parts of the airlines cost is the cost for ground handling services, to reduce waiting time and downtime of the aircraft on the ground, it is necessary to optimize the use of the resources and personnel involved in ground handling process.

In order to optimize ground vehicles movement at aerodrome a computer simulation can be used for the purpose of testing new methods of transport movement control at aerodromes. Also, the methodology of the simulation model, and structure of the model which has been designed to optimize transport means flows during movements of airport ground vehicles including aircrafts, is demonstrated in this article.

The developed model will be used to conducting experiments, which may help to find more effective airport ground processes and control techniques.

Such model can be created for any airport. Using such model, we can check the ability of technical implementation of new control technologies of ground vehicles at aerodromes including aircrafts itself.

During this research we planned to set up dynamic model and will try to solve two tasks:

- The analysis task, which is used to determine the limits of the control algorithm's efficiency, for any given type of monitored event; in other words, what technical means will be used to provide the monitoring of relevant events.
- The synthesis task, which is used to determine the types of monitoring of events and the appropriate technical means to be used, which are required for the implementation of the predetermined control algorithm.

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## DEVELOPMENT OF THE TRANSPORT INFRASTRUCTURE OF LATVIA: PLANS AND REALITY

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**Keywords:** transport infrastructure, development, indicators, evaluation

Transport infrastructure is an integral part of the transport system of any city or state.

The current approaches for the maintenance and the role of the transport infrastructure in the modern cities should be re-evaluated and re-considered under the pressure of the permanent growth of the urban population and the growth and development of the business.

Latvia is located at the heart of Europe’s fastest-growing area – the Baltic Sea region. The transport and storage sector’s success is based on Latvia’s favourable combination of an advantageous geographic location, providing access to the Russian and western European markets, a competitive labour force and excellent infrastructure with three ice-free ports, the best railway connection to Russia and a fast-growing air transport sector.

Latvia provides access not only to the European market but also to the border-free Schengen zone (LIAA, 2016).

There is a number of the issues the contemporary transport infrastructure of Latvia is facing. First of all, it is the reciprocal competition and the development issues. It is vitally important both to provide the monitoring of the current status of the infrastructure and the containing units, and to follow the plan of the reconstruction and maintenance of the functionality of the system in general.

The main tasks of the research are:

- to evaluate the current level of the development of the Latvian transport infrastructure based on comparative analysis of plans and the reality of their implementation;
- to identify the main factors that hamper of the transport infrastructure development in Latvia.

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## EVALUATING RIGA TRANSPORT SYSTEM ACCESSIBILITY

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**Keywords:** urban transport system, public transport, accessibility, measures

Accessibility can be defined as the ease with which an individual can reach a location to perform an activity. Providing a link between transportation and land use models accessibility can be seen as an indicator to assess transport and land-use policies, especially in urban structures. A definition of accessibility is given by (Morris *et al.*, 1978). In (Litman, 2012; Geurs and van Wee, 2013) provides an overview of literature into ‘accessibility’, found different factors that affect accessibility: transportation demand and options, mobility, information, integration of the transport system etc. The measures of accessibility are diverse and can be person-based, measuring the opportunities at the individual level, or location-based, measuring the number of opportunities accessible from one location (Geurs *et.al*, 2001). Person-based accessibility accounts for individual factors affecting one's ease of reaching its desired destination, whereas location-based accessibility presents aggregated measures. The most common measure of location-based accessibility is the cumulative-opportunity measure, that counts the number of opportunities that can be accessed from one location within a given travel time (Geurs and van Wee, 2004).

In many countries and cities, improving accessibility is an important government goal. In (Yatskiv and Budilovich, 2016) authors discussed the new project - Riga Multi-modal Transportation Hub and offered the procedure for evaluation of accessibility measures of Riga Transport system before and after the planned reconstruction. In this study analysis of current state of accessibility for Riga Transport System were conducted.

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## MESOSCOPIC SIMULATION FOR AUTOMOTIVE INDUSTRY APPLICATIONS

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Based on the discrete rate simulation paradigm, mesoscopic simulation is settled between discrete event (microscopic) and continuous (macroscopic) simulation. Both the level of detail and the effort for model creation and calculation are less compared to discrete event simulation and higher compared to continuous models (Reggelin, 2011).

While mesoscopic simulation is to perceive as methodology for a comparatively strong aggregation of a real system, discrete rate simulation describes a technical approach to realise the mesoscopic concept within in simulation software. The idea of discrete rate simulation arose in 1997, when this new kind of modelling was introduced by the company Simulation Dynamics. Developed further by Imagine That Inc. since the early 2000s, nowadays discrete rate simulation is well implemented in ExtendSim – a simulator, which is preferably used to model mesoscopic systems. Discrete rate simulation unites qualities of system dynamics (continuous simulation) and discrete event simulation: Like system dynamics, discrete rate is a flow based paradigm, dealing with stocks and flows to simulate dynamic systems (Krahl, 2009). But in contrast to the continuous approach, the system state of a discrete rate model is not changed by integration of differential equations (Sterman, 2000). Instead, the system behaviour is defined by resolving linear equations in different time intervalls. This leads to a discrete behaviour of rate based models. Furthermore, similar to discrete event simulation the variation of system states in discrete rate models is also event driven (Damiron and Nastasi, 2008).

These characteristics make the mesoscopic approach relevant for some kinds of tasks related to production and logistics planning. As reported by Schenk *et al.* (2014) planning tasks can be classified according to their time horizon to fullfill. More precisely, planning tasks are differentiated into operational, tactical and strategical tasks. Operational tasks have a time horizon of less days till a few weeks and are characterised by decisions regarding the day-to-day-business. The tactical planning deals with a period of several months or years and includes for instance procurement, production planning or definition of distribution channels (Kuhn and Hellingrath, 2002). Long-term business decisions with a scope of three years and more are related to the strategic planning level. Obviously, the use of mesoscopic simulation seems to be reasonable for supporting short-term decisions, to which a microscopic abstraction would not be practical regarding the time-consuming modelling effort compared to the relative short period of time until decisions have to be settled.

Therefore one main objective of this study is to identify typical tasks in the automotive industry for which mesoscopic simulation could provide significant advantages in the phase of

planning. In the next step the opportunities of mesoscopic methodology will be evaluated with a simulation study of a real problem from the automotive industry. The problem originates from an assembly plant of the BMW Company. A mesoscopic model will be created, which represents the goods inwards department of the assembly plant with all relevant logistics processes. The results of the mesoscopic model will be compared with the results of an already existing discrete event model, to figure out the proximity of the results to the microscopic model, looking also on the modelling effort and the runtime for simulation.

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## SOCIO-TECHNICAL INNOVATIONS IN URBAN LOGISTICS: NEW ATTEMPTS FOR A DIFFUSION STRATEGY

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**Keywords:** Actor-network theory; adoption; innovation diffusion; socio-technical analysis; socio-technical co-evolution; sustainable urban logistics

Against the background of continuously dwindling natural resources and demographic change, on the one hand, and international competition on the other hand, logistics gets besides its economic function a social mission: The elaboration of smart solutions for the implementation of sustainable technologies. This task presents itself particularly urgent in the area of traffic systems, in which sustainable innovations do lack of diffusion, as statistics shows (KBA, 2015). The economic volume of traffic in German cities demonstrable rises and produces negative externalities like traffic, emissions, noise, decreasing road safety and quality of stay (Kutter, 2004). In order to counter this, the EU transport policy aims a shift to CO<sub>2</sub> neutral urban logistics by 2030 (European Commission, 2011). In spite of the political developments and the negative impact on society resulting from the traffic volume, the adoption of environmentally friendly vehicles like electric cars and cargo bikes remains minimal. In conclusion appears a yawning gap between a relatively active production of scientific results and new political aims towards well-levelled processes in social systems, which seem to be resistant to change.

To close this gap social and economic sciences i.e. provide diffusion and life cycle models, like the theory diffusion of innovations (Rogers, 2003), which describes the process of social innovation adoption by individuals and social systems. The categories of adopters (Innovators, Early Adopters, Early Majority, Late Majority, Laggards) give an empirically scrutinized review of the target groups to be addressed in the right chronological order to achieve a successful adoption process. The linear modelling of the course of diffusion from developer to adopter, which only allows the build-up of a causal communication chain in the following order: Message → Channel → Receiver → Effects to spread the new idea, has often been criticized (Karnowski *et al.*, 2011). The demand of an active involvement of the potential adopter in the communication process of innovation development has remained unnoticed.

What role can and should logistics play in this respect?

The idea that is pursued with the present paper is the strengthening of logistics in its character as a cross-sectional science, especially by focusing its normative part. Lying crosswise to engineering, economic and social sciences as well as to mathematics and informatics, logistics is at least theoretically virtually predestined for translation processes between technical innovations and social needs. The “peek behind the scenes” of social systems that logistics practices by analyzing and modelling material and information flows, reveals what the science theorist Bruno Latour means by the expression: “Humans are no longer amongst its peers” (Latour, 2000). Operational but also social relationships organise themselves through so called technical “third parties”, which Latour designates “actants”. This happens under a growing public awareness and leads to a concept of socio-technical co-evolution abolishing the dichotomy of subject and object.

This approach is part of the actor-network theory (ANT), which arised at the interface of engineering and social sciences itself (Latour, 2005). In this thinking humans and technical artefacts transform within mutual action processes to so called “hybrid-actors”, which come into being by four fields of technical mediation. In its application to the topic of the present paper,

the reasons for the lack of diffusion can be examined by reviewing inscribed action guidelines in electric vehicles (Translation), investigating the so far compositions of adopters and i.e. cargo bikes (Composition), understanding the electric vehicle as a complex system by itself (Reversible Blackboxing) as well as analyzing the articulation conditions of the electric vehicle as an independent acting actant within a hybrid society (Delegation) (Latour, 2005). As a constructive aim, recommendations for decision-makers in politics and economy shall be derived.

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# SIMULATION TECHNIQUES FOR EVALUATING SMART LOGISTIC SOLUTIONS FOR SUSTAINABLE URBAN DISTRIBUTION

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**Keywords:** City logistics measures; simulation; goods distribution; evaluation

Urban distribution of goods is considered as one of the key factors to cities' problems on traffic congestion and environmental pollution. The ever growing demand in transport of goods renders the upkeep of a high traffic and living quality, in cities a challenging process. Urbanization, consumerism, technological blooming and international competition cause a vast demand of products and services and make essential priority the distribution of goods within urban areas for public authorities.

Over the last decades, many smart logistic solutions have been developed to allay cities' problems related to distribution of goods. These solutions complement traditional Urban Freight Transport (UFT) measures or replace them entirely. However, new approaches are always generated towards those smart solutions, rendering their implementation dreaded in terms of adequacy and sufficiency, due to the lack of past experience. Especially in a multi-dimensional environment as the urban environment in combination with the multivariate nature of logistics measures, their implementation can bring adverse effects if all aspects are not considered carefully. To avoid such situations, modelling of the proposed measures-solutions is always advised, in order to be quantified and evaluated.

Micro analytic and macro simulation has proved to be a valuable tool for planning, designing and evaluating the contribution of the urban goods transport to urban economy and environment. Simulation of different scenarios can be assessed on the basis of interaction of city's attributes e.g. topology, local regulations, with the properties of the proposed UFT measures. On market various simulators can be found, all aiming at the evaluation of the impacts of the concerned measure in the four principal sustainability impact areas (economy & energy, environment, transport & mobility, society) (Papoutsis and Nathanail, 2015).

Aim of this paper is to present the current state of practice in modelling smart logistic solutions, to provide a roadmap in simulation techniques for UFT measures, to improve the knowledge around the patterns currently followed and to make comparisons, assessing simulation techniques applied for different urban areas or different logistic solutions.

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# METHODOLOGICAL FRAMEWORK FOR THE EVALUATION OF URBAN FREIGHT TRANSPORT INTERCHANGES FOCUSING ON URBAN CONSOLIDATION CENTERS (UCC)

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**Keywords:** evaluation, framework, urban, freight, transport, UCC

During the last two or three decades, there has been a considerable increase in the freight transport needs in both interurban and urban context, resulting in deep impact on human and natural environment. In most of the cases, the seamless movement of cargo throughout the whole supply chain and the interconnection of interurban and urban transportation networks is accomplished through the establishment and operation of intermodal freight transport interchanges, the Freight Centers. The Freight Centers play a very important – key role, as they constitute the nodal points where the cargo assembled is transhipped from large units (e.g. containers, pallets etc) transferred by heavy good vehicles (HGVs) to smaller ones carried by little dimensioned, more flexible and environmental friendly vehicles performing the last mile distribution in urban areas. Such city logistics techniques, although it may seem cost and time consuming, have been proved to be cost effective, traffic alleviating and environmental preserving.

In this paper, the focus is set on the Urban Consolidation Center (UCC) to be established in the metropolitan area of Graz, Austria. Included within the most common Urban Freight Transport (UFT) policies and measures worldwide, the UCC is believed that it will contribute to the upgrading of the local urban economy, mobility, sustainability and liveability. The UCC concept is examined and analysed using the Evaluation Framework developed within the NOVELOG project. The framework uses scientifically proven methodologies, considering the UCC concept through a life cycle sustainability approach, mapping the activities, involved stakeholders and impacts through all its life cycle phases from creation - construction, through operation and maintenance to closure – disposal – back logistics. The framework is composed of five (5) modules:

1. The Social Cost-Benefit Analysis Module. It correlates life-cycle processes for UFT measures' realization with economic parameters and social costs and benefits.
2. The Impact Assessment Module. Depending on the candidate city particularities and also according to the city needs, objective goals and expectations, it develops a support choice mechanism for identifying the proper methodology to be adopted providing guidance for assessing impacts of applied UFT measures.
3. The Adaptability and Transferability Module, which identifies requirements for implementing UFT measures, maps specific problems and bottlenecks faced when implementing those measures at various implementation phases and establishes measurements for assessing adaptability and transferability of measures.
4. The Risk Analysis Module, which identifies risks in UFT measures implementation (analysis of potential risks in UFT measures implementation, classification of risks in external and internal) and advices for the corrective actions (prevent, mitigate, transfer, tolerate).
5. The Behavioral Modelling, incorporating techniques for facilitating estimation of behavioral changes in adopting UFT measures, as well as for supporting qualitative

data collection needed for the identification the impacts on multiple criteria, by multiple stakeholders.

The evaluation framework reflects a total of seven impact areas distinguished within two levels. The first level comprises the four (4) sustainability disciplines, incorporating economy and energy, environment, transport and mobility, and society. Within the second level, the three (3) “applicability enablers” are included, namely: policy and measure maturity, social acceptance and users’ uptake. Each impact area is associated to respective criteria and key performance indicators.

Evaluation incorporates a multiple weighting scheme, and elimination and ranking techniques and models, for the facilitation of “shared” decision-making, taking into account the participation, viewpoint and contribution of all involved stakeholders to the conformation of the final decision made on the measures. The functions of the evaluation, following the concept of multi-stakeholder multi-criteria assessment methodologies, lead to the estimation of the Logistics Sustainability Index (LSI). Focusing on “UCC concept”, some interesting conclusions, results and findings are produced after the application of the Evaluation Framework.

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## PROVIDING GUIDANCE FOR TRANSIT MANAGERS AND OPERATORS IN ORDER TO INCREASE THE QUALITY OF THEIR SERVICES

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**Keywords:** transit quality of service; gap model, decision trees, j48 algorithm

At each transfer point and taking into account their minimum generalized travel cost, travellers shape an optimal for them strategy to follow for their trip. This generalized cost, is strongly related with transit quality of service aspects and differentiates among different type of travellers. The quality of a service has mostly been studied in terms of marketing, as it comes from social and business sciences. One of the most known models to assess service quality is the GAP model, proposed by Parasuraman et al. (1985), to investigate the service quality gaps in an organization considering at the same time both costumers' and marketers'/operator's' beliefs, expectations, perceptions and standards. Five GAPs have been examined in terms of this model, between: 1) users' expectations and operators' perceptions of users' expectations, 2) operators' perceptions of users' expectations and service quality specifications, 3) service quality specifications and service actually delivered, 4) service delivery and the communications to users about service delivery and 5) users' expectations and perceived services. The present paper deals with the fifth GAP of the model, known as the quality GAP, as this is the gap that users' decision to select a transit service (i.e. if users expect a higher quality level than the one perceived, they tend not to use the service). This GAP has been assessed for the Greek transit system case. We used an internet based questionnaire to collect users' expectations and perceptions of 26 selected transit quality indicators, based on a 5 point likert scale. Following, we developed a decision tree using the J48 algorithm linking users' perceptions and expectations with the overall quality of service assessment. The decision tree analysis depicts the importance of various quality components in the generalized cost estimation. Research findings shown that the performance indicator “Availability of information by phone, mail”, was the most crucial parameter for the overall assessment of the service, while both performance and importance variables participated in the tree formulation. Tree paths provide guidance for transit operators and/or decision makers for increasing the quality of their services and at the same time enhance performance efficiency and operation profitability.

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## SIMULATION BASED DSS DEVELOPMENT FOR RIGA AIRPORT CAPACITY EVALUATION

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**Keywords:** simulation, decision support system, capacity evaluation

Riga International airport is largest airport in Baltic States. It has direct flights to over 80 destinations in 30 countries. The statistical data for the last 5 years shows around 5mln. passenger turnover. Riga International airport is important transport hub, not only for Latvia, but also for neighbouring countries (Lithuania and Estonia). Passenger traffic statistics of the Baltic Countries for Riga International airport shows, that 45% are from Riga and 55 are from Lithuania (Vilnius, Kaunas) and Estonia (Tallinn). Not looking to the fact, that in 2015 the Ground Handling Department of Riga International Airport and the ground handling services company HAVAS EUROPE achieved a high punctuality ratio, by providing good quality, professional services to the carriers with punctuality ratio of 99.58%, which is an excellent result in the aviation industry, still the strategic goal of airport authorities is to create, maintain and improve positive customer experiences by providing high-quality services. It means that airport should put a lot of attention on developing different types of the information services in order to keep high quality level. In general the information services could be classified as: user-orientated services (main goal to provide data and services to the end users) and own-orientated services (main goal to support internal activities of airport).

The goal of this article is to present the development of the decision support system (DSS), which is based on simulation application, for Riga International airport. The DSS is orientated on evaluation of the capacity of the airport. Here must be underlined, that capacity here is referenced not to the passenger capacity of the airport, but to the capacity, which is related with serving flights. The choose of simulation for the DSS development was done after analysis of the scientific literature and articles. There are number of examples, how simulation is applied for similar task (Bubalo and Daduna, 2011), (Wijnen *et al.* 2008). The core of the DSS is the simulation models developed in AnyLogic simulation software. The simulation model aggregates supply and demand model. The supply model represents the infrastructure and resources of the airport, meanwhile demand models defines planes schedule (as planes are demanding for the airport resources).

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## EVALUATION OF TRANSPORTATION COMPANY LOGISTICS ACTIVITIES EFFICIENCY

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**Keywords:** criterion, redundancy, benchmarking, costs, , key performance indicator

Logistics activities of a transportation company involve integration of tasks, and especially topical is the choice of methods and means of evaluating the effectiveness of its logistics activities. As the analysis of the sources of modern logistics shows, there is no single point of view regarding the composition and structure of performance indicators of the effectiveness of logistics activities within the scientific community yet. Two problems determine research relevance:

- different indicators provide different and often conflicting evaluation results;
- the most important or the most general indicator has to be chosen, or some more complex or systemic approach should be used.

The aim of the research is to study and analyse existing approaches for evaluating the effectiveness of the logistics activities of the transport companies.

Basic topics of this research are:

- description and analysis of existing logistics approaches for assessing the effectiveness of the transport companies logistics activities;
- development of recommendations for improving the methodology for assessing the effectiveness of the transport companies logistics activities.

The efficiency is one of the most common economic concepts that still do not have single universally accepted definitions. This is the most important qualitative characteristic of a system, in particular – economical system, in terms of the costs and results ratio of the system operation (Lopatnikov, 2003). This definition of efficiency can be accepted in the logistics science, taking into account the rules of 8R (Logistic-info, 2016).

The concept of "logistics activities" (LA) is often used as a synonym for the word "logistics", and it does not differ from terms such as "logistics system", "logistical operation", "logistic function" (Stock and Lambert, 2005; Waters, 2009). According to the definition of the logistics of the European Logistics Association (European Certification Board for Logistics, 2016), the leading scientists consider logistics activities as a set of traditional activities of enterprises.

Evaluation of the effectiveness of logistics activities that includes both quantitative and qualitative indicators is one of the most critical issues for transportation companies (Stock and Lambert, 2005).

The most common quantitative indicators of logistical activity used by enterprises are indicators of the delivery of products to customers, inventory turnover rate, product return rate, and the supplier relationship cost. Less than half of the companies use expenses as an indicator (Waters, 2009). Benchmarking (the process of comparing one's metrics to industry bests) is one more approach to solve the problem (Waters, 2009).

Quality of service is an important indicator that cannot be directly calculated but can be described by a set of measurable rates (Dybskaya *et al.*, 2013).

It is most often considered in the literature that the main criterion of the efficiency of the logistics system is a minimization of logistics costs (including costs of transportation,

warehousing, materials handling, inventory management, order management, information and computer support costs etc.) (Lukinskiy, 2014).

It is relevant to focus on minimizing costs only when necessary level of logistics services is reached. A multi-criteria evaluation of the efficiency of the logistics system becomes therefore more common, and key performance indicators (KPI) are used more widely (Lukinskiy, 2014; Tyapukhin, 2007). Currently, as a result of the development of logistics in developed countries, a system appeared that consists of various KPIs and allows to evaluate in general the effectiveness of a logistics system (Sergeev, 2016). However, the problem of mutually conflicting evaluations of separate indicators groups remains unsolved.

It is also possible to use a Balanced Scorecard (ITKOR Institute, 2005). This approach involves the use of different indicators for different enterprises, but it can be relevant for a single enterprise, but not for the whole system.

Thus, it can be seen that, for any of the approaches described above, the criteria and indicators redundancy shows lack of logical completeness in evaluating the effectiveness of the logistics activities of the transport companies. There should be some common procedure (probably existing in other areas of knowledge) that could be applied in logistics.

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