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ABSTRACTS

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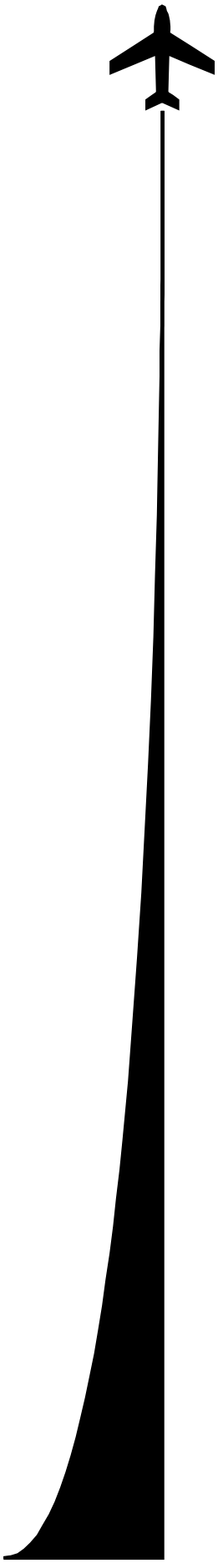

Plenary Session

INTELLIGENT CITIES AND INTELLIGENT TRANSPORTATION SYSTEMS: LINKING TWO RESEARCH AGENDAS

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Keywords: intelligent cities; intelligent transportation systems; research agendas; decision making

The purpose of this presentation is to discuss two complementary research agendas about "intelligent cities" and "urban intelligent transportation systems" (U-ITS). We argue that U-ITS research should be placed into the wider research agenda for intelligent cities, taking input and data from other urban subsystems (i.e. housing, work, recreation), creating synergies and commons into urban infrastructures (i.e. energy grid, G-cloud) and producing more radical changes to mobility patterns and more intelligent ways to deploy infrastructure. The talk is structured in four parts.

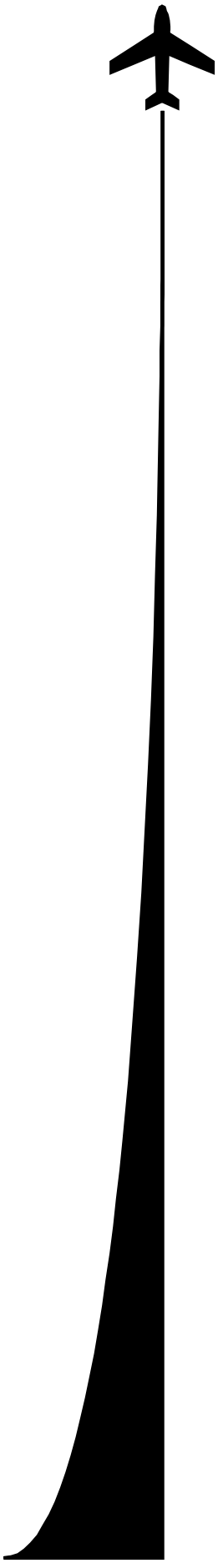
The first part is about the concept and functioning of intelligent cities as environments enabling innovation-for-all. Here we give a summary outline of the evolution of innovation environments, from inside the company Schumpeterian views to contemporary open, user-driven and democratising innovation, and place intelligent cities within this evolutionary perspective of innovation environments.

The second part continues this discussion with the presentation of mechanisms of innovation within intelligent cities. These take the form of innovation circuits that start from (i) software applications development, which in turn (ii) introduce more informed (intelligent) and participatory decision-making, (iii) and novel solutions to the workings of cities. We discuss also the main knowledge functions and forms of collaboration that strengthen those innovation circuits.

The third part moves to a more pragmatic perspective focusing on software applications for intelligent cities and U-ITS. We examine a number of solutions from the ICOS repository (http://icos.urenio.org/) and mainly solutions related to urban mobility, parking, and decision-making, which are actually used in the framework of intelligent / smart cities. We will outline two strands of U-ITS:

- A strand that focuses on monitoring and metering urban mobility, making those data available, describing and revealing transport patterns, and enabling participatory processes of decision-making for the improvement of cities and urban networks. Included are solutions for citizens' and stakeholders involvement in policy making, real-life observation of mobility patterns, experimental test-bed into urban living lab environments. The added-value of such solutions is long term, influencing policies rather than individual travel choices.
- A strand that offers a better allocation of resources, optimising travel behaviour in the use of urban transport. Such systems include applications for multimodal mobility in cities, urban information and alert systems, park finding and online payment, GPS guidance. The concept behind this type of solutions is that of 'smart grid', which is placed over the urban transport system, enabling better access, management, and use of cities. The added value of such solutions is to be found in time and mobility cost saving, at the level of 5%–15%.

The final part is about the links and benefits of integration between the research agendas of intelligent cities and U-ITS. These two research agendas define solutions that every city should have: systems supporting the daily function of cities and systems to optimise urban infrastructure in the long-run. However, the level of savings achieved from solutions for better use of urban transport is rather limited and does not balance the increase of mobility and cars in cities. In the long run, such systems do not provide a sustainable solution to urban transport. We should therefore search for more fundamental changes of urban mobility patterns, in terms of mobility generation, travel choices, infrastructure, and transportation means, by creating bridges and synergies within the entire landscape of applications, commons, and infrastructure for intelligent cities.



Session 1

Transport Systems

IDENTIFYING MODAL SHIFT BY UTILITY FUNCTIONS TO ENHANCE REGIONAL DEVELOPMENT

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Keywords: utility function; modal shift; stated preference, regional development

The aim of this study was to analyse the modal shift of passengers by analysing their preferences in order to enhance regional development. If the preferences of passengers are known it is possible to simulate how the modal shift of the investigated area would change if there are some changes in the investigated parameters of transport services (e.g., implementing a new transport service or introducing new development strategy).

To capture the preferences of passengers stated preference method was used in online questionnaire. Five key factors were identified (from the point of passengers): travel cost, travel time, comfort, safety and environmental efficiency. In these factors three levels was predefined as simplification which made the base of the choice model. At every replier three alternatives were got and they were told to choose the best for themselves. From the results of the questionnaire the formulas and the parameters of the mode choice utility function was derived and identified. In the reviewed statistical sample an exponential utility function showed the best matching. For the validation process a probability model was set up to be compared to the proportions of the utilities.

With this utility function it is possible to handle possible future transport services by evaluating the services through the defined five factors. Based on the introduced statistical approach the described method can be used to identify the effect of transport development on regional development.

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THE EAST-WEST TRANSPORT CORRIDOR ACTIVITIES GOVERNANCE

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Keywords: transport corridors, management, governance, planning, infrastructure

The keynote of the development is effective integration of the EU countries and East countries transport sector into East–West (EW) transport corridor service system and transport services market complying with the common criteria for transport development in the corridor.

All countries, which cross EW transport corridor, governmental authorities must consolidate the results of complex joint international efforts directed towards specifying the long-term plans for further East–West transport corridor development perspectives. These decisions must give the priority status at the highest governmental level to the EW transport corridor international importance, crossing the territory of 8–10 countries. The focus in the decisions must be given to the better use of the existing infrastructure, "intelligent" management of traffic, networks and systems.

Due to the East–West transport corridor countries specific nature and needs and apart the EW corridor, the region is covered by its own transport network. One of the biggest present problems is insufficient transport infrastructure and long border crossing procedures limiting international accessibility for goods and passengers.

To define a mission of public authorities in the field of development of the transport system, it is essential to analyse two most important segments of this broad system: the infrastructure and its users (carriers, operators) having different specific features of functioning and activity development. Transport networks in EW corridor countries are a drive for competitiveness of a common market artery or even of markets. Therefore, the development and modernization of transport infrastructure is one of the essential measures that ensure economic progress in working out national economy development strategies and programmes of both the EU, CIS and other East countries.

Better integration as EU, CIS and other East countries transport into the socio-economic development processes of the region is required. Bridging EU, CIS and other East countries transport networks could increase the region's accessibility.

On the basis of the results of surveys (October 2013, March 2014) is recommended that the development of the East–West transport corridor (infrastructure and activities) implementation should encompass the assessment of the current capability of the existing systems and transport infrastructure facilities, which would be impacted on or be a part of the East–West transport corridor development programme. This requirement is needed to identify any emerging constraints in respect of the capability of existing asserts of facilities, which would be required as a key component of the overall programme. It must be noted that East–West transport corridor may be developed over a number of time periods and as such, the demands placed on the system and the emergence of new technological solutions is likely to require refinements to functional specifications at a local and regional level.

The joint action plan must highlight the areas and components of the transport system, which are important for the effective interconnectivity of the individual networks, and/or for absorbing the steadily increasing intraregional and transcontinental freight flows.

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HOW TO DELIVER THE NECESSARY DATA ABOUT SERIOUS INJURIES TO THE EU?

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Keywords: road safety, serious injuries, MAIS3+

In the EU in 2011 the number of victims of serious road injuries was more than 250,000 and the death tolls were 28,000.

In the last period (between 2001 and 2011) the number of those who lost their lives as a result of road accident decreased ordinarily by 43 percent in the EU countries on average, whereas that of the seriously injured by 36 percent – in the light of these countries' own definitions differing from one another. If the two data are compared there are quite a lot who point out that while during the same period in the EU on average the number of fatalities decreased by 43%, on the contrary that of the seriously injured by 36% "only". The analysis presents the relationship between the two data, then points out their effective factors and the raison d'être of the term "only".

According to the White Book of the European Union the number of fatalities had to be reduced by 50% over the past decade, and for the next period (2011–2020) the latest action programme of the EU sets also this requirement for the Member States.

The common (the so-called 30-day) definition of the victims killed makes the evaluation and comparison of the expected decrease possible in the Member States; however because of the variety of definitions this is not possible anymore in the case of serious injuries.

Until 2011 according to the definition used in Hungary that person was considered as seriously injured who in a road accident has suffered injuries to be healed beyond eight days. The definition was changed in 2011 and the new definition of the seriously injured included among others a hospitalisation for more than 48 hours in seven days following the date of injury.

In other countries the seriously injured are determined according to the duration of hospitalisation, the type of injury, incapacity, or even according to the duration of healing.

The MAIS3+ is the adopted common EU definition, that is all 3-grade or above values according to the Maximum Abbreviated Injury Scale (MAIS).

Although the definition seems professionally justified, in our view further clarification is necessary. Actually, because, by definition, the persons of AIS6 classification – representing those injured who lose their life on the spot – belong also to the group of seriously injured, consequently there is a risk that the fatally injured are taken into account twice.

Thus it is the common definition's inaccuracy that the interval in question is open on a side, so we believe that the interval from MAIS3 to MAIS5 would be really adequate for the precise definition of the seriously injured.

For the years 2014 and 2015 the EU has already drawn up specific tasks for the Member States. The presentation, which accounts with the reality of each option as well, takes into consideration the possible ways of implementation. The need for solving the problems requires the Member States' common thinking and efforts. Since the Baltic States were particularly successful in the field of road safety in the last 10 years, it is certain that in the future they can do a lot in order to have the number of serious road accident victims significantly reduced and also internationally compared and assessed.

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THE OPTIMIZATION VARIANTS OF POSTAL TRANSPORTATION NETWORK

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Keywords: optimization, postal transportation network, distance, time, infrastructure, p-median

Optimizing process of the postal transportation network can be based on several variables and on the different infrastructures. The most commonly used variables for optimization are time and distance. This article is focused on comparison of the results of optimization process based on the time and distance variables in the conditions of the Slovak national postal operator.

The different types of underlying infrastructures (roads or railways) could be used for optimization based on territory conditions. For the optimization the p-median method is used, that described the problem of locating P "facilities" relative to a set of "customers" such that the sum of the shortest demand weighted distance between "customers" and "facilities" is minimized.

In conclusion of the article authors will formulate the rule for selection of the best optimization variables for optimization of postal transportation network.

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CONTROLLING CONCEPTS FOR GREEN TRANSPORT CORRIDORS

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Keywords: Green Transport Corridors, Controlling, Networks, Balanced Scorecard, KPI

Green transport corridors represent trans-shipment routes with a concentration of freight traffic between major hubs and by long distances of transport marked by reduced environmental and climate impact. Important properties of green corridors are their network structures, their transnational character and their high involvement of public and private stakeholders, including political level, requiring new governance models. Network-oriented controlling of green transport corridors requires new concepts and instruments concentrating on multi-dimensional evaluation of collective strategies and processes in an international environment with a focus on cross-company aspects.

Until now the scientific discussion focuses on different sets of Key Performance Indicators (KPI) for monitoring and management of green corridors, which are mainly covering sustainable aspects of green corridor development by neglecting a network-oriented controlling approach so that a general concept for green corridor controlling is still missing. First experiences with implemented green corridor projects reveal that the exiting KPI sets strongly depend on the underlying governance models. Beside that the KPI approach emphasizes the operational aspects of the corridor performance so that a strategic controlling concept is needed to safeguard an efficient, innovative, safe and environmental friendly long-term development.

The paper will present and discuss current controlling concepts for green supply chains and link the ongoing scientific discussion to recent research results about green corridor management. In order to solve the strategic weakness of the existing green corridor controlling concepts a new green corridor balanced scorecard approach based on cooperative and network-oriented concepts will be presented and tested on the base of empirical data of existing green corridor implementations. As a consequence of the empirical analysis it will be shown that this green corridor balance scorecard approach has the potential to serve as a suitable controlling instrument for managing an effective and efficient green corridor development, which is independent of specific governance models.

THE FUTURE OF AUTOMOTIVE - AUGMENTED REALITY VERSUS AUTONOMOUS VEHICLES

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Keywords: autonomous vehicles, augmented reality, intelligent driving assistant.

Autonomous Vehicles (AV) are the field of interest of many research groups. An Augmented Reality (AR) research in connection with a Driving Assistance (DA) research contributed to market launch several systems. Success in both research areas is a fact, although AV is not connected with any solution on the market. This article is going to show where is the border between those two fields of interest (using some examples from the past few years and new ideas) and how they are going to influence on the future of automotive. Besides authors show how Head-up Displays (HUD) and sound can be used in AR. Authors also present their own AR system - Intelligent Driving e-Assistant (IDEA) - based on soft-computing methods used for an object classification problem.

Augmented Reality (AR) and Autonomous Vehicles (AV): two approaches, two different types of understanding of the future of automotive. AR solutions give driver a chance to change a way of driving (make it easier, safer and much more reliable), whereas AV eliminates driver at all. This paper presents main features of both approaches and gives a necessary background to show the IDEA system developed by the authors at Wroclaw University of Technology. It is a driving assistance system created to recognize road events and inform a driver about e.g. road signs, pedestrians, unidentified dangerous objects only using some voice (specialized voice alerts). IDEA works as an autonomous solution without any interference with a driving process. General Assumptions:

- *IDEA* informs a driver about various types of road events e.g. recognises speed limits, traffic jams, obstacles;
- system is autonomous and needs only a power supply;
- system works in a real time;
- *IDEA* cannot have any direct influence to a driving process;
- devices used for a prototype cannot be especially assembled; they must be widely available;
- software developed for *IDEA* should use most known algorithms adapted for special tasks.

An application developed for *IDEA* system is modular. Each module is a part of the application responsible for a special task. Functional blocks and modules communicate to each other using some specified data and parameters. Each module can be controlled outside the application by control parameters without which its processing is impossible. The control parameters are very important. Their values determine a correct *IDEA* processing. *ADC* is a device, which converts a camera signal to digital frames in a specified format (readable for the application). Extraction block is a set of modules, which processes frames. Contours selector is responsible for finding and selecting contours in a frame, which is processed. Classifier block is a set of modules, which consists of two subsystems: a classifier and learning subsystem. The first one works in "a real time". *IDEA* research process is divided into three parts:

- architecture concept and application development;
- laboratory tests;
- real environment tests.

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. Further challenges such as *DARPA* Grand Challenge will show the trend of development. Nevertheless future changes in a law should give a motivation for an automotive industry to commercialize developed autonomous solutions. But there is one open question for *AV* developers: are people mentally prepared to share roads with robots?

COMPARATIVE EVALUATION OF MOTOR TRANSPORT ENTERPRISES USING SELF-ORGANISING MAPS

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Keywords: motor transport companies, efficiency, financial performance, self-organizing maps

In the Latvian economy the motor transport industry currently is one of the most important and the largest sectors of the economy both by the number of employed people in it, and by the share in GDP. Development of transport depends largely on the overall economic development of the Republic of Latvia therefore resource efficiency industry is a key task.

Feature of the motor transport industry is the presence of a significant number of enterprises importantly differentiated both in terms of assets, and on the net turnover, making it difficult to assess their relative effectiveness with traditional economic indicators.

Financial statements are the basis for evaluating the economic efficiency of resources' use of the motor transport industry.

On the basis of the existing financial statements the methodological apparatus evaluating the effectiveness of the company allows the calculation of financial ratios, cash flows and other indicators using different approaches, the most common of which is a cost.

Among these indicators that are widely used in the international comparisons the ROA, ROE, ROS, ROI, EVA, EBITDA, CFS indicators are.

These indicators are successfully used for integrated assessment of individual companies or for comparing of a relatively small number of similar objects.

Calculation of certain financial ratios, reflecting the effectiveness of the company refers to a one-dimensional method, involving the processing of each variable independently. Comparison of a significant amount of the motor transport companies even on limited criteria is technically difficult because of the volume of the analysed information.

Therefore, large groups of variables require the use of multivariate methods of analysis.

One of the methods of a multivariate analysis allowing an overcoming of disadvantages of the traditional financial analysis is the use of self-organizing maps. The self-organizing map is the competitive neural network teaching without a teacher, performing the task of visualization and clustering. Application of self-organizing maps greatly facilitates the evaluation and allows you to work with large volumes of data.

Building of self-organizing maps by using of financial data allows getting a comprehensive picture of the economic potential of a large group of the motor transport companies.

NEW POSSIBILITIES IN TRAFFIC MANAGEMENT IN THE CITY ROAD NETWORK

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Keywords: road traffic, driving strategies, management, traffic lights, multiagent environment

Annually increasing growth of transport leads to deterioration of the efficiency of the transport system; increases the amount of congestion situations not effectively used roadbed. There are several ways to solve the problems: the expansion and modernization of highways (the most effective and expensive), the improvement of traffic management systems (development and optimisation of traffic light control, adaptive control (Anfilets and Shuts, 2010), etc.), new methods of driving flow control. Improvement and optimisation of transport systems and means of traffic control often doesn't bring significant benefits, but usually costly. So, it may be more efficient to optimise behaviour of drivers (Kasyanik and Shuts, 2012). Implementation of such system is carried out using the existing infrastructure of mobile devices that are now almost everyone. Practice shows that the introduction of smart managing crossroads is expensive and time-consuming task. New approach is needed to optimise traffic. Instead of adjusting the transport system for traffic flows, we can inform drivers in real time about the situation at intersections with traffic lights and allow drivers adapt to the green signal lights.

Widespread smartphones, navigators and other devices with built-in GPS receiver allows you to capture a significant percentage of drivers and invite them to use our system called "Mobile driver's assistant".

As part of the road network, vehicles fitted with mobile assistant driver, can be seen as autonomous agents. Traffic in the city will be a multiagent environment (Mikhnevich and Shuts, 2012). Knowledge of location, direction and speed of each agent can move us to a new type of traffic control.

The driver starts with a traffic light only to slow down after 500 meters. Even if the road is empty, traffic lights make us wait for the green light - there are typical problems of "foolish" road infrastructure. Intelligent prediction of times of traffic lights switching is able to save a lot of fuel in town cycle because the driver stops less often and engine idles not so much. It's better for driver to know how fast he must move to get on the green light. This project provides such opportunity.

There are several automobile consortiums that developing technology for universal road "data bus" which could support all vehicles as well as traffic lights and other road facilities. For example, the "Audi" company announced details about the technology "Audi Travolution" recently (MIT News Office, 2011), which displays the driver's distance from the nearest traffic light and recommended speed.

So, the car can increase the speed of itself, if not falls into so called "green wave on the contrary it can signal the driver of imminent signal changing (visual or acoustic alert or by brief interruption of the gas pedal).

Tests have shown that the machine saves an average of 20 ml of gas at every traffic light by using such a system. Surely, Audi is not the only company that is working on the creation of "automobile internet". A program called "Safe Intelligent Mobility-Test Area Germany" (SIM-TD) is experiencing now in Germany by a consortium involving Audi, BMW, Daimler, Ford, General Motors, Volkswagen, Opel, Bosch and Continental (MIT News Office, 2011).

Proposed in the given work system for non-stop passage of the road network includes a mobile communication device or another mobile driver's assistant (let's call them MDA), which is located in the vehicle and connected across the WAN with a server computer, that is connected to the city traffic lights control centre. These devices are equipped with special software that performs the necessary calculations. Such a design allows using the software for non-stop passage of the road network on any vehicle without costly upgrades of traffic lights.

The system works as follows: the server computer has permanent access to information about current traffic signals and their location. MDA are turning to the server computer for the geocoded information about the parameters of traffic lights, when required. Using the parameters of its current location and received data, MDA calculates the optimum speed of unceasing movement to the next traffic lights and then outputs the information to the driver. The driver performs non-stop passage, following the recommended speed. Such system takes into account the relevant parameters of both basic and additional sections of traffic lights and recommends speed for all possible directions (Kasyanik and Shuts, 2012).

Using such systems at traffic lights significantly reduces transport stops, safety of both vehicles and pedestrians is ensured.

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SAFETY INSPECTIONS OF RAILWAY CROSSINGS AND STRENGTHENING OF INDIVIDUAL RESPONSIBILITY FOR SUSTAINABLE TRAFFIC SAFETY

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Keywords: hazard ranking, review criteria, scoring system, enhanced security actions, traffic awareness, features of railway crossings

The dangerous characteristics of railway crossings come from the fact that a crossing is a contact point of different traffic systems, where structurally different traffic paths cross each other. These different kinds of paths are used by vehicles with significantly different technical parameters. Therefore the railway crossings have prominent importance in terms of traffic safety. Because of the facts above, and in addition due to a ministerial instruction released in 2003, the most dangerous railway crossings must be determined. The basis of this determination is an establishment of a hazard ranking (Tigyi and Gábor, 2010). This hazard ranking can be created using a total score per crossings indicator generated by a data processing algorithm. Within the project called 'Safety Inspection of Railway Crossings in the Area of Railway Track Sections Extended to the Border of Burgenland and West Hungary' (Sicherheitsinspektionen von Eisenbahnkreuzungen entlang der grenzüberschreitenden Bahnlinien in Burgenland und Westungarn – SIEBaBWe) by the examination of several possible modelling techniques (Pokorádi, 2008) we created a model which is suitable not only for the determination of the railway crossings' hazard ranking in our project, but also it is applicable for every railway crossings. The point creation was the common element in the potentially attractive models; the method of this point creation meant the difference. Regarding to certain models a mentionable common feature was the demand of counting with the environmental characteristics of railway crossings, the accident and traffic data and the way of insurance. New ranking components was built into the model which are taking account of the given railway line's regional or long-distance role as well as the results of surveys about the crossing's use habits. The railway crossing, where the implementation of enhanced security actions are the most reasoned, can be designated by model outputs which are checked and filled with proper data.

In terms of the expected impacts related to modernization at first we have to take into consideration the fact that based on statistical surveys the additional semi-turnpikes are significantly increase safety in the given railway crossing. Moreover we can talk about a financially profitable investment; it can be justified by economic calculations. However the other changes and additions proposed in the reconstruction catalogue are providing extra information for the crossing's user; on the one hand the approaching user can realize the dangerous area more intensively, and on the other hand these information are helping in the deliberate forming of needed and desirable traffic behaviour in crossings, thereby further reducing the chance of accidents.

Beyond the enhanced security actions included in the reconstruction catalogue the safety inspection is integrally complemented with the strengthening of road users' responsibility in every society groups along regional and main lines. The main objective of raising awareness (Arató et al., 2014) is the increased safety of railway crossings and the reduced number of accidents.

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EVALUATING TRAVELLERS' LEVEL OF SATISFACTION AT A GREEK URBAN TRANSPORTATION HUB

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Keywords: urban transport; decision tree; interchanges; city hubs; public transportation systems

This paper studies the level of satisfaction of travellers using the New Railway station of Thessaloniki, in terms of services provision and station's operation as a transportation hub. Eight main categories of indicators were examined, related with: mobility information provision, way-finding information, time and movement issues in the station, accessibility, comfort, station "image" and attractiveness, safety and security and emergency situations.

The study aims at:

- Pointing out the level of users' satisfaction from the existing station operation, infrastructure and services;
- Understanding station users' decision making process and travel behaviour;
- Pointing out the key performance indicators that formulate the overall satisfaction level for a transportation hub from users' point of view;
- Comparing users' hierarchy approach with operators and decisions makers (based on the state of the art review on the decision makers key performance indicators) and point out any potential similarities and/or differences;
- Evaluating the above attributes in terms of the urban transit trips made (focusing on mode choices) and users' profiles, special characteristics and needs.

For the data collection process, an extended questionnaire survey took place in the hub, where 2000 station users were invited and 256 travellers agreed (participation rate: 12,8%) to participate (completed the questionnaire) by stating their level of satisfaction from aspects related to the station infrastructure, operation and services, as categorized in the eight main categories of indicators examined. The surveys run in two time periods, from 29/07/2013-10/08/2013 and from 16/09/2013-27/09/2013.

A decision tree approach was used to point out the key indicators in users' satisfaction formulation for the transportation hub. The results of this research indicate the type of the segments that have significant impact on perceived station performance of travellers, regarding the examined indicators.

Highlighting the findings of the study and evaluating the parameters affecting the satisfaction level of users, it has been observed that there is a need to:

- Clean the station more often, as many believe that the cleanliness level is very low (almost 64% of the sample assessed an under satisfied level of this indicator);
- Regenerate the surrounding area (45% of the sample was not at all satisfied);
- Enhance the internal design of the station (58% of the sample was not satisfied);
- Create a new parking area at the station, able to accommodate car mobility needs and enable more combined trips with car and public transportation (coming from users' suggestions).

Research findings point out the most important parameters that should be modified in order to increase users' satisfaction, which will gradually increase station's usage too. Moreover, this approach will provide significant input into proper design and operation of transportation hubs, efficient usage and guidance on methods' to increase users' satisfaction.

The research is part of the European project City-HUB (www.cityhub-project.eu), which aims to develop an integrated business model and proposes a comprehensive set of methodological guidelines, addressing different aspects of an urban interchange and promoting public transport.

STAKEHOLDER TYPOLOGYAND DIMENSIONS OF GREEN TRANSPORT CORRIDORS

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Keywords: green transport corridors, cluster governance, stakeholder typology, strategy

Since the appearance of the White Paper on Transport in 2011 the concept of green transport corridors represents an important element in the future of EU Transport Policy. The green transport corridor approach stresses European trans-shipment routes with a concentration of freight traffic. There are different ways to understand the meaning of transport corridor and to describe and understand such corridors. One important approach is a network-based view, which allows seeing the corridor as a conglomeration of different stakeholders acting along a defined geographical area in order to create sustainable logistics solutions. The stakeholders in such a transport corridor can be characterized by typologies so that the local properties of a transport corridor can be derived by its regional stakeholder composition.

The paper will present recent research results about stakeholder typology and its application to a better understanding of the dimensions of green transport corridors. Since green transport corridors can be regarded as tubular service clusters, which are built of regional parts with their own stakeholders, the typology approach gives the opportunity to understand the values and strategies of stakeholders on meso-level and to find successful and sustainable governance models for green transport corridors.

THE IMPACT OF ACCESSIBILITY ON TRANSPORT INFRASTRUCTURE WITHIN COMMERCIAL SITE

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Keywords: accessibility, simulation, trip generation, traffic impact studies

Land use patterns (Litmann, 2011) have significant impacts on transportation and mobility for the macroscopic, mesoscopic and microscopic scales. There are four ways how to identify accessibility measures (Geurs and Wee, 2004): infrastructure-based, location-based, person-based and utility-based measures. All these measures are interrelated and are focused on how to reduce travel time or distance travelled by motorized and non-motorized modes and improve walk-ability, cycling and public transport facilities at the macro and meso levels.

In the traffic impact studies (micro level) accessibility is affected by different activities within a commercial, office or residential land. Activities include pedestrian and bicycle conditions, transport infrastructure changes, network capacity, level of service within a site. The aim of this paper is to provide better understanding of how transportation infrastructure changes within the commercial site influence on car-based trip generation rates at micro level. Transportation changes include development of new connections to the site: signalling and not signalling intersections with different allowed traffic movements. Three parameters: demand, supply and readiness were considered and analyzed.

Readiness (the number of traffic flows at the connections after changes in geometrical parameters) was determined by Synchro/Simtraffic 6.0 simulation tool with assumption that the level of service of the site connection should be better than D / E. Verification and validation of simulation model was performed. Demand for commercial site was calculated based on ITE trip generation rates (ITE, 2010) taking into account "smart growth" criteria for local conditions (Zenina and Borisovs, 2013). Supply including existing incoming and outcoming traffic flows for the commercial site was observed by the survey (Solvers, 2012).

Road connectivity index before and after infrastructure changes was calculated to compare with results received from analyzing demand, supply and readiness parameters for the commercial site.

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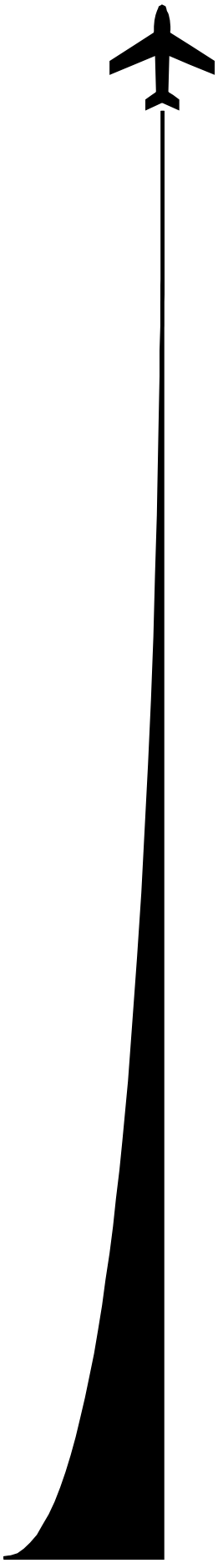

Session 2

Transport Logistics

CLASSIFICATION OF LOGISTIC PRODUCTS IN TERMINAL NETWORK MULTIMODAL TRANSPORTATION

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Keywords: multimodal transportation, concept, terminal network principle, the terminal network, warehouse terms

Multimodal transportation is a system of international transportation of goods by two or more modes of transport. This goods movement is impossible without the development of unified transport terms and conditions, which form the transport product (Palagin, 2009). The detailed research showed us that one of the important parts of the transportation is freight forwarder product.

From the analysis of the technology of international multimodal transportation, it is determined that the services that provided to the client are optimal route and calculated through rate. We can achieve efficiency in these elements by the usage of international transport corridors, cross-docking, advanced transport and technology delivery system, cargo consolidation, transportation outsourcing, different types of logistics providers and more.

Some advantages that customer would choose international multimodal transport forwarder are – having one person responsible for the cargo and its transportation, ensuring the safety of cargo, price characteristics, option of customs clearance, option of issuing a multimodal transport document received by domestic and foreign banks, financial transparency between customers.

List of forwarding services in the terminal network is wide. Forwarder organizes movement part of the process (including the monitoring of transportation), handling operations, warehousing, etc.

One of the main components of the forwarding services and transportation costs is terminal handling charges. Thus, it is very important to optimize these costs.

To facilitate understanding of the warehouse obligations we have developed a version of storage services classification. For each condition, there are specified code, responsibilities of the parties, price of services and group of warehouses that will perform the necessary work.

The aim of the classificatory of terminal products is to provide a set of terminal uniform tariffs of the most commonly used trade terms terminal handling. Knowledge of the uniform tariffs allows to a customer and to a forwarder itself have advantages as opportunity to plan terminal costs, legal protection of customer's responsibility and tariffs transparency.

This classification has a potential to be used in the small storage companies, and regional and international levels.

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DEVELOPMENT OF THE ALGORITHM FOR DESIGN AND REENGINEERING OF LOGISTICS DISTRIBUTION NETWORK

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Keywords: wholesalers, development trends, logistics, logistics infrastructure, distribution network, design algorithm

The current situation in the fast moving consumer goods market in Russia is changing drastically: the growing influence of retail chains on the manufacturer and the dynamic growth of logistics intermediaries make wholesalers seek all possible ways to ensure the reinforcement of its market positions. There are following main trends in the development of wholesale trade market in Russia:

- The turnover of wholesalers in Russia is growing and the direction of goods distribution is changing.
- Logistics infrastructure of merchant is in progress.
- New models of relationship between finished-goods wholesalers and manufacturers are appearing.

Practice shows that the main tool of competitiveness improvement and even more survival of merchants is an effective alignment of logistics. Distribution network design, ensuring maximum market cover with optimum costs of promoting trade flows based on the customer requirements is becoming the most important task of any wholesale company.

Design of the rational distribution network (or its reengineering) is often the response of the company's logistics to the implementation of new corporate strategy involving changes in territorial consumers' penetration, growth of sales or service policy shift. Logistics can initiate the distribution network reengineering making a decision about the distribution strategy switch or ineffectiveness of existing network after its thorough analysis. In this case existing distribution network is usually reorganized (or reengineered).

In this paper an algorithm for design and reengineering of logistics distribution network is proposed, which is based on the models of supply chain network structure optimisation, system analysis and benchmarking. The algorithm comprises the following steps:

1) Analysis and assessment of the existing logistics network distribution performance.
2) Identification of the main paths of logistics distribution network reorganization.
3) Direct design (reengineering) of rational logistics distribution network:
   - 3.1. Forecasting of sales and markets development.
   - 3.2. Analysis and evaluation of the use of both existing distribution system and specific supply chains in the proposed paths of logistics distribution network reengineering.
   - 3.3. Selection of distribution systems for each trade area.
   - 3.4. Definition of the optimal structure of the distribution system.
   - 3.5. Creation a set of alternative logistics distribution networks.
   - 3.6. Choose of a rational logistics distribution network and determination of costs associated with its implementation.
   - 3.7. Monitoring and control of the logistics distribution network performance.

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MODEL OF DECISION SUPPORT FOR ALTERNATIVE CHOICE IN THE LARGE SCALE TRANSPORTATION TRANSIT SYSTEM

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Keywords: Transport model, transit, decision support, the Baltic Sea Region

In the situation of strong competition between ports in the Baltic Sea Region (BSR) and clear-cut ascendancy of alternative routes, the BSR is facing a need for major economic restructuring, and efforts to achieve more integrated and sustainable transport links within the BSR are needed.

One of these efforts is the development of ports and logistics centres and their networking, which will continue to have an impact on improving communication links, spatial planning practices and approaches, logistics chain development and the promotion of sustainable transport modes. These factors will reflect on logistics processes both in major gateway cities and in remote BSR areas.

The objective of paper is to suggest the multiple-criteria approach for evaluation and choice the alternatives of cargo transportation in the large scale transportation transit system with special attention to the Baltic Sea Region. The multimodal transportation system with finite number of known alternatives defined by the routes and modes of transportation is considered. Each alternative is represented by its performance in multiple criteria.

The large scale transportation transit system is presented by directed finite graph, which is an ordered pair D = (V, A) where V is a set of finite vertices (railway stations, ports, border points and logistics centres) and A is a set of finite arcs **(**transport lines between ports and/or logistics centres). The vertices are grouped in clusters. In each cluster only one vertex can be used as alternative for transit routes. Each vertex v_i ($V = \{v_i\}$, $i = 1,\ldots n$) is characterized by an individual set of key performance indicators K_{vi} and each arc a_j ($A = \{a_j\}$, $j = 1,\ldots m$) is characterized by an individual set of parameters P_{aj}.

Several alternatives for cargo delivery can be found, determined by different routes and modes, which form the vector space of a family of alternative transit vector routes.

In the paper a model for decision of route choice is described, the finite graph of the large scale transportation transit system with special emphasis on BSR is presented, the criteria of optimisation are formulated, and the set of key performance indicators K_{vi} and set of parameters P_{aj} are described.

TRANSMODAL SHIPMENT: DEFINITION AND FORMULATION OF OPTIMISATION PROBLEMS

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Keywords: various transports, plan of the transport system, transmodal shipment

Produced analysis of modern transport market participants (including both transport operators and the public to accept the status of former intra-industrial carriers, such as JSC "Transport Company "LUKOIL-Trans", JSC "Severstaltrans", etc.) shows that operated transportation characterized by the familiar complicated structures formed logistics systems.

At the same consignment with the ultimate goal of increasing the efficiency of transportation is distributed by type of transport and vehicles. Accordingly, the structure takes the form of transport links operated by combining a number of series and parallel multimodal transport – so called "transmodal" transportation (Kirichenko, Denyak, 2007).

Thus, it is useful in the interests of the study and optimisation of these systems to put into circulation the term "transmodal shipment", under which a swarm of means: *a fixed amount of cargo transportation of one or more interacting senders with serial and parallel use of several types of transport and transport enterprises, performed on a single plan of the transport operator*.

It should be noted that the approach indicated the presence of a single cargo waybill as mandatory characteristics of trans-carriage is not mandatory. You must have a single contract between the cargo and the transport operator.

Managerial decision-making in these conditions requires, on the one hand, the decision block optimisation problems dynamic programming (constellation and key) and, on the other hand, a balanced management system formed chains (unlike flows, chains rely on specific subjects). Of course, said chain with goods produced complexes logistics operations (up scaling and downscaling packages, temporary storage, etc.).

The optimisation problem of transmodal shipments seem mutually exclusive requirements is in alignment problems mentioned classes, because this combination leads to unjustified from the standpoint of common sense, globalisation mathematical model of functioning.

So, we know that by now formulated two concepts of constructing an optimal plan transport system by means of economic and mathematical methods. One of them comes from the description of the object of planning as a single "global" economic-mathematical model. This concept is based on the writings of transport means by V. N. Obraztsov, V. V. Zvonkov, V. G. Bakaev and others who have studied the transport sector of the economy as representing a single set of all modes of transport (Kirichenko, Kuznetsov, Izotov, 2013).

However, at the moment, due to the dismemberment of the transport industry, the acquisition of economic independence is no real coordinating body control and transport network, this approach is associated with many difficulties, both theoretical and practical nature.

The second concept involves the construction of an optimal plan for the functioning of the transport network by describing the object through the planning system of interrelated economic and mathematical models of the functioning of individual links on the modes of

transport. On the basis of such a system multiple-step planning process can be arranged, when each step processes only a part of the information and solves local problems functioning of the transport system. By the early 1990s, scientists' transporters have established the theoretical basis for this approach (Kirichenko, Kuznetsov, Izotov, 2013).

Scheduling optimisation problems are solved with iterative methods: each model in the course of solving conditionally alienated from ties with the entire system, and these connections are fixed at a certain level. Then, after a meaningful analysis of a number of models, identifies and assesses the achieved values of parameters of interest and plans, after the necessary proof, newly translated. Incremental calculations are repeated until a plan of operation such large and extra large transport systems for which any changes would have been impractical, not increase its utility for all subsystems hoc logistics system.

In modern conditions advantage of the second approach seems obvious. Since the main content of the logistics organization of material flow is the integration of individual unit's cargo chain into a single system capable of adequately responding to the external environment. The most difficult step of forming a workable and manageable system of trans-shipments is to analyse the various available options in the transport market, choice and association in a rational combination transport subsystems, elements, which belong to different owners.

Obviously, this explains the direction of further research on the topic.

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LAYER MODEL OF THE POSTAL SYSTEM

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Keywords: postal transport network, postal system, processes, layers model

The paper is devoted to problematic of the postal system. It can be analysed by postal processes along the value chain. Whereas the postal sector belongs to the network industry, but also in the communications industry, at the analysis it is possible to observe the similarity with other systems such as transport and telecommunications. On this basis, the paper shows that by use of sufficient disaggregating, the postal market/system can be analysed by network layers or both along the processes (including clearance, transportation, sorting and delivery of items) as well as along the layers. This new "network layers approach" will be represented by designed postal model based on three layers. The first one consists of applications/services provided by postal infrastructure, the second layer consists of the active part network layer (technology of transportation) and the third layer is a passive infrastructure (vehicles, transport routes…) of postal network. The conclusion of the paper will include important aspects of the layer model such as making the possibility to define rules for regulating, technical and technological requirements and interfaces to communicate with other postal systems. This will promote interoperability of the systems.

Acknowledgements

VEGA 1/0421/12 Modelling of diffusion knowledge in corporate value chains.

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SMART FACTORIES AND THEIR IMPACT ON SUPPLY CHAIN RISK MANAGEMENT

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Keywords: supply chain risk management, risk management process, risk classification, smart factories, mitigation measures

Currently the industry sector lives through a change which is caused by altered framework conditions such as global competition, shortage of resources, demographic change, urbanization and increasing complexity as well as volatility. Hence, companies are more than ever challenged to achieve flexibility, low error rates, high workload and improved efficiency. The German Federal Government has launched a research program approaching "smart factories" to enable the affected companies to cope with current and future business environment. This proposal is a sub-project and part of the overall nationwide high-tech strategy.

The concepts and technical approaches which are summarized under the term "smart factories" describe a new step in development of the organization and control of the entire value chain. This progression is based on the vision of achieving highly flexible manufacturing processes in order to be capable of responding to dynamic customer requirements in a minimum of time. It is needless to say that this approach cannot be made at any expense. Thus, the additional requirement to produce the emerging large number of variants economically in small lot sizes is essential. From a technical point of view this high level of flexibility is allowed by intelligent networking of cognitive and (temporary) autonomous systems. These the so-called cyber-physical systems (CPS) characterize small-sized computers equipped with sensors and actuators that are integrated into materials, objects, devices and machine parts. In order to use their full potential they are interconnected and create an "Internet of Things" unifying the physical and digital world. In the future many of the production and logistics processes will be controlled and coordinated over great distances in real-time. The exceedingly diversified customer orders will be allocated to the (global) production units by the CPS themselves according to the principle of self-organization. To ensure an ideal allocation to the available resources the process considers the outcome of a situational acquisition of current requirements.

From this change of paradigm regarding organization and control result extensive consequences for the configuration of the value chain, the business models including downstream services and the work organization. Due to their character as cross-sectional function, in particular logistics and supply chain management are affected by the concepts of "smart factories". The impact of decentralized decision making through CPS is, especially in the field of intra-logistics already matter of intensive debate and research activities. However, an expansion to other fields in logistics exists only to a minor degree. Accordingly, impacts to the supply chain risk management (SCRM) were so far hardly considered.

Therefore, this paper discusses and analyses the consequences of "smart factories" on SCRM resulting from the described technical and organizational innovations. The aim is to identify arising changes to the risk landscape and to derive the required further development of the SCRM. By considering the risk management process and the risk classification which is

mainly applied in the phases of identification and evaluation, in particular the core elements will be examined (Kersten et al., 2011). Subject of special interest in this regard are on the one hand alterations or new characteristics of risks and on the other hand possibilities and necessities to modify the risk management process. For this purpose a comprehensive literature analysis will be conducted and the findings will be validated by interviewed experts. The compiled measures and strategies may be employed by the manufacturers and their business partners to deal with the up-coming consequences enforced by "smart factories".

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STATUS ANALYSIS OF LOGISTICS CONTROLLING AT RUSSIAN COMPANIES

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Keywords: logistics, company, controlling, inspection, questionnaire, system analysis, research technique

Logistics practice shows that the best results in business are obtained by those companies that use the concept of integration in logistics, which allows efforts joining of company's key personnel and logistics inter-mediators in end-to-end control of commodity and information flows in an integrated business structure: "projecting – acquisitions – production – distribution – sales – service". Logistics controlling has two aspects: firstly, establishment of a certain measures system (of quantitative and qualitative indicators, namely, KPI, criteria, attitude and preference scales); secondly, directly measuring outcome of logistics decision-making.

To evaluate logistical efficiency and logisticians' activities in an enterprise it is necessary to have a procedure of measuring Logistics department employees' decisions. Estimation of logistics business process results is an essential requirement of reaching the goals of a logistics system, as this provides feedback needed for effective management (Sergeyev, 2004, 2005, 2007) showed in these works – that measurement of logistics work outcomes has two aspects: firstly, setting a certain system of measures (KPI, criteria, ratio scales and preferences); secondly, direct measurement of logistics decisions results.

The article presents the results of the research on logistics controlling at Russian companies. As a result of the research the author carried out a system analysis of logistics controlling condition and development trends at Russian companies in production, trade and services sector. In the framework of the research logistics top managers of Russian companies were interviewed about logistics controlling. The survey took place in a form of written and online questionnaires. The results are documented and processed by special instruments.

The study of logistics controlling has been initiated in International Logistics Training Center (ILTC) under the supervision of NRU-HSE in 2012 by on-line surveying of logistics top-managers of Russian companies. For the analysis were selected 145 companies. The objective of the investigation was to study organizational methodical aspects of logistics controlling in Russian enterprises as well as an analysis of logistic KPI influence on companies' business effectiveness. The study aimed to assist improvement of planning of logistics controlling and assessment of logistic indicators.

Companies were surveyed by written and online questionnaires.

Logistics top-managers (directors, logistics departments and divisions' chiefs, logistics coordinators, integral logistics managers and others) who took part in the research individually assessed the following components of logistics controlling:

1. Organizational structure of logistics service,
2. Logistical costs accounting,
3. Logistics budgeting,
4. Reporting,
5. Special instruments of logistics controlling,
6. Logistics performance estimation,
7. Effectiveness controlling of supply chains.

After statistics from questionnaires has been analysed and deviations from rational logistics activities has been found, we present factors, which could potentially influence logistics activities of a company. We should point out that for visual aid the study's results and data manipulations are graphically presented by MS Excel.

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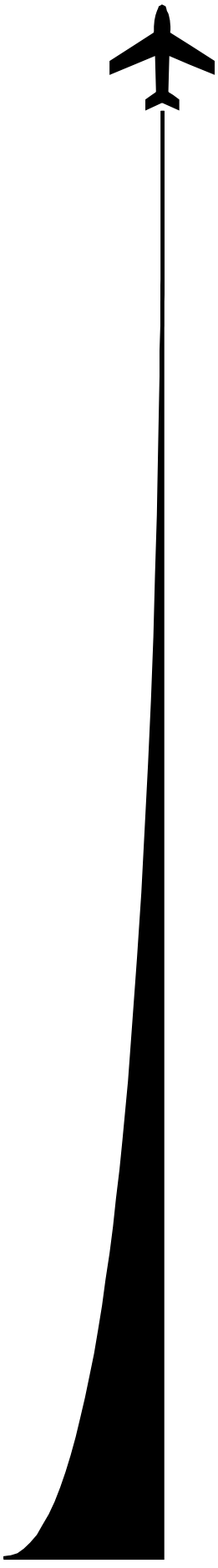

Session 3

Reliability and Maintenance

RELIABILITY OF SUPPLY CHAINS IN A RANDOM ENVIRONMENT

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Keywords: continue time Markov chain, survival function, polynomial approximation

Considered supply chain consists from sequential links of a supply, c is a number of the links. The supplies are performed sequentially. A new supply begins after a successful ending of the previous supply. Let $W(r)$ be a perform time of the r-th link, $r = 1,\ldots, c$. It is supposed that the corresponding distributions are continuous ones and are concentrated on finite intervals. All random variables are independent.

The supply chain operates in the so-called external random environment. The last is described by an ergodic continue time Markov chain $J(t)$, $t > 0$, with the finite space of states E and the transfer intensity $a(i, j)$ from state i to state j. This process is modulating one for the random sequence $\{W(r)\}$ (see Pacheco et al., 2009; Andronov and Gertsbakh, 2014). If the external environment $J(t)$ is in the state i and the r-th link is performed, then fatal failure can arise with the intensity $\gamma\ (i, t)$.

The supply chain will be performed successfully if all c links will be performed without failures. We need calculate the corresponding probability, i.e. a reliability of the supply chain, and a distribution of chain's performance time.

Embedded Markov chain is introduced in a consideration. Differential equations for transition probabilities are derived. A polynomial approximation is used for their solution. On this base, survival function of one link is computed. It allows calculating the chain reliability and performance time distribution. A numerical example is considered.

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THE EVALUATION OF THE RELIABILITY OF SUPPLY CHAINS: FAILURE MODELS

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Keywords: supply chains, reliability, failures, calculation models

Apart from the criterion of total logistics costs that is used to evaluate the efficiency of supply chains, another criterion – the total satisfaction of consumer needs – is increasingly used for the same purpose. It should be emphasized that the methodology, models and methods of calculating total logistics costs are developed in reasonable detail while questions of evaluating the quality and reliability of executing logistics operations and functions require further research. It can be explained by the transition to such new logistics concept as the sustainability of supply chains, which is characterized not only by flexibility, rate of response, strength, adaptability, but mostly by reliability of functioning of logistics system's elements.

Performed analysis of different sources showed that despite the presence of individual solutions researchers don't give the necessary attention to failures, which are the central concept of the reliability of supply chains (Blanchard, 2004; Lukinskiy et al., 2014); most of calculation models are based on probabilities of faultless operation of the elements, which, in its turn, were obtained by processing the statistical reporting of logistics departments (Ballou, 1999; Wolfgang and Thorsten, 2006); the number of variants of simple failure models is limited (mostly, they are the models of perfect order) (Ballou, 1999; Lukinskiy et al., 2012); description of complex failure models that take into account several logistic operations were not found in the sources, which were available to reviewers, etc.

The results of the research are given below:

1. Critical analysis of existing approaches to the formation of failure models in supply chains was carried out.
2. The methodical approach and classification of failures for key logistics functions (purchasing, order processing, transportation, storage, warehousing and materials handling) was proposed.
3. Failure models for a number of logistic functions and operations were developed and improved.

Presented models are based on the general theory of reliability of complex systems (Gertsbakh and Kordonsky, 1966; Lukinskiy et al., 2012) and disciplines that are included in operations research (probability theory, the theory of stochastic processes, queuing theory, the theory of recovery, etc.), in particular, on the theorem on numerical characteristics, repeated experiments, the compositions of distributions, the transformation of random variables, etc.

Approbation of methodical approach was carried out on the basis of the data published in various sources as well as on the basis of collected information about indicators of reliability of logistics enterprises (transport companies, warehouses, etc.). The developed models can be used to evaluate the reliability of existing or planned supply chains, for decision-making about optimising the total logistics costs and improving service levels.

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EXPERIMENTAL STUDY OF A ROLLER BEARING KINEMATICS THROUGH A HIGH-SPEED CAMERA

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Keywords: diagnostics, roller bearing, fault, bearing retainer rotation frequency

To perform diagnosis of technical state of a bearing, vibration diagnostic models (Novikov et al., 2007) are used, which correlate typical fault parameters with testing parameters. As such testing parameters, the advanced models use amplitudes and frequencies of vibration components, which can serve as damage criteria of roller bearing items (outer race, inner race, and balls).

Calculation of characteristic frequencies of a bearing requires knowledge of its geometrical parameters. For example, the work (Takács, 2012) contains some formulas of characteristic frequencies (corresponding to rotation speeds of bearing retainer and balls) with a single external damage of the inner race and the balls. However, theoretical calculations of those parameters normally neglect the lubrication impact on the rotation speed of bearing retainer and balls.

To determine the lubrication influence upon the bearing retainer and the balls rotation frequencies, an experimental study of the bearing kinematics was carried out. To conduct the study, a special-purpose pilot plant was developed whereon the bearing under study was mounted; in process of the bearing rotation, shooting with a high-speed camera (15000 frames/sec) was accomplished. In the course of the study, a roller bearing assembly was used with a degree scale imprinted on the bearings, the inner race, and the bearing retainer, enabling one to determine the angle of rotation of the roller and the inner race when processed the video picture. The videotape footage was subsequently processed by using customized software to determine the bearing retainer and the balls rotation frequency depended on the lubricant type and condition.

The series of experiments conducted allowed us to draw conclusions on the effect of lubrication on the kinematics parameters of a bearing and on the diagnostic capability of the currently used bearing diagnostic methods, as well as improve the diagnostic model of vibration signals shaping, taking into account operating conditions.

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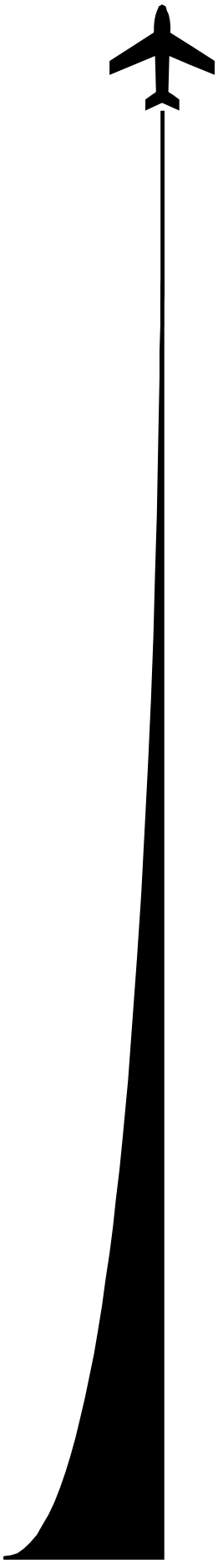

Session 4

Intelligent Transport Systems

GPS/GLONASS TRACKING DATA SECURITY ALGORITHM WITH INCREASED CRYPTOGRAPHIC STABILITY

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Keywords: GPS/GLONASS, matrix encryption, AES, Triple DES

Vehicle monitoring and control systems are an integral part of any modern transport and logistics company. Real-time tracking of vehicle location and its condition is allowed by implementing these kinds of systems. But what would happen if someone will make changes in information that has been transmitted from the vehicle to the transport and logistics company server?

The number of hacker attacks is growing each year in all areas and transport with logistics are not exception. Monitoring and tracking systems are using satellite navigation systems GPS or GLONASS only for determination of vehicle position and its speed. All information about vehicle including satellite data is transmitted via telecommunication and computer networks, which make up the main gap in data protection.

Some modern monitoring and tracking systems are equipped with data encryption/decryption module, which is based on block cryptographic algorithms such as advanced encryption standard (AES) and triple data encryption standard (Triple DES). However, there are new articles and publications on breaking cryptographic algorithm AES (Kang et al., 2013), (Das and Bhaumik, 2014) and Triple DES (Kodera et al., 2013), which contains new hacking algorithms every year. The rapid development of computer industry leads to significant time reduction for hacking cryptographic algorithms allowing us to make for one second more and more computational operations.

One of the possible ways of data protection based on one-time pad principle, the symmetric cryptographic system with absolute hacking resistance, is proposed in the article. An encryption/decryption system is based on matrix transformations, which consists only with integers $\pm 2^n$, where $n \in N$.

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USING OF THE ADAPTIVE ALGORITHM FOR NARROWING OF THE PARAMETER SEARCHING INTERVALS IN INVERSE PROBLEM OF ROADWAY STRUCTURE MONITORING

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Keywords: radar, roadways, radar monitoring, inverse problem, genetic algorithm

Radar monitoring of roadway is an operational method to obtain information about hidden processes and tendencies that precede the visible destruction of the road. The results of radar monitoring can determine the best action and the necessary volume of repair and reconstruction of the roadway (see, for example, Loizos and Plati, 2010; Saarenketo, 2005, 2006; Tosti and Benedetto, 2012).

For the purpose it is necessary to perform reconstruction of electro-physical parameters of roadway coverage with detection and identification of inner zones and objects. Reconstruction of electro-physical characteristics of the roadway structure is in essence identification of electro-physical parameters of the layers, which can be achieved by solving the inverse problem of roadway structure monitoring. Earlier (Krainyukov, Kutev and Opolchenov, 2010; Krainyukov, Kutev, 2011) we investigated the inverse problem of roadway structure radar probing in the frequency domain basing on the method of selecting, when the informative parameter was represented with the spectral density of the signal, received by the ground-penetrating radar. The probed roadway structure is characterized by electro-physical parameter vector $\overset{\cdot}{P} = \{p_1, p_2, ..., p_n\}$, where n is the number of parameters. Electro-physical parameters of each layer are as follows: thickness h, conductivity σ and of relative permittivity ε' of the layer's materials. The aim function is minimized by applying global optimisation methods: the genetic algorithm and the bee swarm algorithms.

It has been shown (Krainyukov, Kutev, 2013) that narrowing the relative searching intervals of parameters is necessary for decreasing the relative errors of the reconstruction of electro-physical parameters. Using adaptive search interval for each parameter is possible to reduce the parameter reconstruction errors of thickness h and of relative permittivity ε' of the layer's materials of five-layer roadway structure. Reconstruction errors do not exceed 5%.

However, the number of layers of the roadway and the materials from which they are performed vary significantly dependent on the purpose of the roadway and roadway type (AS "Latvijas Valsts ceļi", 2013). Electrical properties of each layer (conductivity σ and relative dielectric permittivity ε') may vary considerably over a period of time, frequently σ and ε' values of layers can be very similar or identical.

Three models of the roadway structure were used in carrying out research. The inverse problem of reconstruction the electrical parameters of the roadway is solved in the frequency domain using adaptive narrowing of the searching intervals of the parameters on the basis of the genetic algorithm. Reconstruction of electro-physical characteristics of the roadway has been made without a priori information about the electrical properties of roadway layers for three values of the half length linear antennas.

The main results of these experiments are the following:

- relative errors of reconstructing of the electro-physical characteristics of the road layers have been obtained for tree models of roadway structures;

- sensitivity of the aim function to the changing each of electro-physical characteristics of roadway structure has been investigated;
- duration of the electro-physical parameter estimation were performed with and without of the adaptive algorithm for narrowing of the parameter searching intervals.

As a result of investigation it has been showed that using of the adaptive algorithm for narrowing of the parameter searching intervals in inverse problem of roadway structure monitoring is essential for improving of data processing effectiveness.

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EXAMINATION OF MULTIPATH STRUCTURE ON SOME ELECTROMAGNETIC TRANSIENTS

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Keywords: system pulse response, empirical mode decomposition, analytical signal, singular value decomposition, amplitude-frequency demodulation, empirical orthogonal function

The aim of this study is to work out an approach to filter the individual waveforms in electromagnetic transient pulses of different nature by digital signal processing methods. Decisions of many problems in geophysics, radar and sonar technologies, medicine diagnostics, etc., have a start from input information contained in some signal waveforms. As contaminated by highly complicated reasons these forms are described in common features only. Therefore, a linear model is postulated most often. It is supposed a signal waveform has formed as convolution of an origin impact with a response function, or pulse characteristics, of some system (e.g., a quadrupole). The last describes a propagation channel of the signal waveform. And at the same time neither origin impact mode nor are channel features unknown in detail, as a rule.

In many cases observed signal would be well to interpret as a result of interference of several waves arrived to the observation point by different paths. It is supposed commonly that multipath signal nature appears due to certain reflections in the propagation channel although true physical causes may be quite other matters. In order to carry out "reduction towards system input" it is necessary to evaluate the multipath influence and eliminate of it from signal structure. These problems are complicated enough. Additional difficulties appear when the signal represents as unique non-repeated realization included in that way all the statistical approaches of attack.

This study examines the utility of some signal decomposition methods as applied to transient electromagnetic pulses (EMP) with different physical parentage.These methods are empirical mode decomposition (EMD), singular value decomposition (SVD) and empirical orthogonal function (EOF) decomposition. Pulse characteristics (i.e., responses on Dirac's delta impulses) of some antennae, as well as EMP radiated by lightning discharges were selected as the experimental data. The main aim is to find out as far as these methods being applied to the same signals are compatible and mutually complementary with one another. The other task is to discover the mutual delays for all the multipath waves. It may be used as the first step to separate waves interfered in the observation point.

Results of processing of real transient forms have been found based on the set of Matlab programs worked out to illustrate the algorithms considered above.

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MEASURING INTERFERENCE AT GNSS SIGNALS

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Keywords: GNSS, GPS, GLONAS, Galileo, Interference

This paper describes the consistent preview of measuring interference at the GNSS signals. The Global Navigation Satellite System (GNSS), as a source of position information available worldwide is considered as a key enabler to future navigation.

The potential for interference exists to various extents in all radio navigation bands. As with any radio navigation system, the users of GNSS signals must be protected from harmful interference resulting in the degradation of achieved navigation performance. Current satellite navigation systems (GPS, GLONASS, and Galileo) provide weak received signal power – meaning that an interference signal can cause loss of service at a lower receiver power level than with current terrestrial navigation systems. Interference exists wherever the GNSS signal is authorized for use. GNSS is however, more resistant to misleading navigation errors from interference signals than current terrestrial radio navigation systems. GNSS signal and navigation systems are not resistant to wilful jammers. After starting on 1st January 2010 a new electronic toll system in Slovakia, increased number of recorded GPS signals interference. Truck drivers who try to avoid toll salary, car thieves, undeclared driving company car, these all are potential users of GPS jammers.

Acknowledgements

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ARTIFICIAL NEURAL NETWORK ADJUSTMENT FOR INVERSE PROBLEM OF PLATE-LAYERED MEDIA SUBSURFACE RADAR PROBING

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Keywords: artificial neural network, ground penetrating radar, radar subsurface probing,inverse problem

The aim of radar subsurface probing inverse problem is tore construct inner structure, as well as, electro-physical parameters of probed media from a set of radar measurements. Solution of the inverse problem for road pavement radar probing may be achieved in frequency domain for the parameter's search range in which it is single and stable. There are several optimisation methods for numerical solution of this problem such as evolution algorithms, gradient methods, and others. Common drawback of the mentioned methods is that direct problem must be solved enormous number of times. This drawback has a dramatical influence on reconstruction of electro-physical parameters of plate-layered media calculation time.

Alternative of evolution algorithms and gradient methods could be artificial neural networks (Kutev and Opolchenov, 2013). They are widely used for data analysis and processing in different areas of engineering applications (Haykin, 1998). Complexity of ANN application is that they need to be adjusted to get acceptable solving result.

We performed model-based investigation of the using ANN algorithm for reconstruction of electro-physical parameters of plate-layered media, which consist of one, two and three layers. Electro-physical parameters for each model layer were thickness h and relative dielectric permittivity ε' of the layer's materials, which values were the same as the ones for asphalt road pavement. Investigation performed with Neural Network Toolbox™ software.

As investigation result of study ANN working parameters' influence on electro-physical parameters of road pavement reconstruction result is presented. Learning data and verified data generated based on the frequency response function of the GPR forward model introduced in the given work (Krainyukov, Kutev, and Opolchenov, 2008). It should be noted that learning data received from the used model must be refined and processed to use it effectively in ANN application. Due this observation, refine methods of the used model data is considered additionally in this paper.

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FIBRE-OPTIC SENSORS CALIBRATION METHOD BASED ON GENETIC ALGORITHM IN WEIGHT-IN-MOTION PROBLEM

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Keywords: telematics, WIM problem, fibre-optic pressure sensors, calibration, evolutionary algorithms

The problem of measuring vehicle's weight-in-motion (WIM) 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.

The fibre-optic sensors (FOS) have become popular nowadays for WIM applications. There are many variations of this technology: low speed LS-WIM, high speed HS-WIM, multi-MS-WIM, and a system for the bridge B-WIM (Jacob et al., 2010). As FOS responds to a pressure, then for WIM measurements it is necessary to estimate the impact area of a wheel on the working surface of the sensor, in order to estimate a tyre surface contact patch (Pacejka, 2006). Developed in frame of the project "Fiber Optic Sensor Applications for Automatic Measurement of the Weight of Vehicles in Motion: Research and Development (2010–2013)" WIM system (Grakovski et al., 2014) consists of: six fibre optic pressure sensors, temperature sensor, induction loop for distinguishing vehicles, and data processing unit for weight and other parameters estimation.

It is necessary to calibrate the system every time after reconnecting the fibre-optic sensor, since the optical coupling is sensitive to weather conditions. The calibration process consists in choosing the normalizing coefficients, which will compare the data obtained from the experiment with the reference data, known in advance. The system and method of calibration of WIM system is the subject of this study. Recorded signals from a group of FOS of a passing truck with various speeds and known weight are used as an input data.

To solve the problem of sensor calibration is proposed to transform it into a problem of optimisation and use evolutionary (genetic) algorithms (Zhao et al., 2013). The results of a truck FOS weighting system calibration based on optimisation algorithm, are being discussed, in order to use this information for axle weight-in-motion estimation.

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EFFICIENT MEASURING OF COMPLEX PROGRAMMABLE LOGIC DEVICE (CPLD) IMPLEMENTED ANALOG-TO-DIGITAL CONVERTERS STATIC PARAMETERS

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Keywords: analog-to-digital converter, differential nonlinearity, integral nonlinearity, histogram method

The precision of analog-to-digital signal conversion plays an important role in digital communication systems. At the present moment, the histogram method is the method mainly used for measuring analog-to-digital converter (ADC) static parameters (Kester, 2005), such as differential nonlinearity (DNL) and integral nonlinearity (INL). In such case the ADC input signal is being changed linearly and output data is used to construct a histogram (Blair, 1994), thus calculating the number of specific codes occurrences. The main problem of such method implementation is necessity to store a large volume of data – ADC output code words during the collection of information. It is usual to use memory modules for such purpose. This article focuses on implementation of histogram method of ADC static parameters measuring based on inexpensive complex programmable logic device (CPLD) arrays. The article proposes histogram real-time calculation algorithm for array, which allows reducing volume of required memory or stopping using it entirely.

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PILOT TESTING EVALUATION OF PORTABLE SYSTEM OF DYNAMIC TRAFFIC FLOW MANAGEMENT AT TRAFFIC CLOSURES

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Keywords: workzones, traffic management, accident, congestion, detectors, portable variable message signs

Problematic localities, which occur on transport infrastructure for a limited time periods during traffic closures, reconstructions, large accidents are an important aspect affecting road safety and traffic flow. The research identified several main factors, which cause significant losses in travel times and which usually cause frequent road accidents. Lower road capacity is responsible for an occurrence of the so-called bottlenecks, which lead to instability of traffic flow. Consequently, drivers may make errors and choose wrong solutions of traffic situations. An important role for the above-mentioned factors is played by incorrect late merge, speeding, tailgating, lower tolerance and consideration to other road users, and nervousness and ignorance of drivers.

In 2011 to 2013, the project ViaZONE was in progress "Traffic Flow Harmonisation and Increase of Road Capacity at Road Works with the Use of Co-operating ITS Systems – Portable Traffic Management", which was to design an intelligent system with the aim to eliminate the mentioned risks and reduce economic losses generated by traffic congestions.

Reliability of all used components of the system was verified during pilot testing. Regarding traffic management, the system showed some problems due to undisciplined drivers and the system proved that speeding in these hazardous road segments is a common practice, which caused accidents and congestions.

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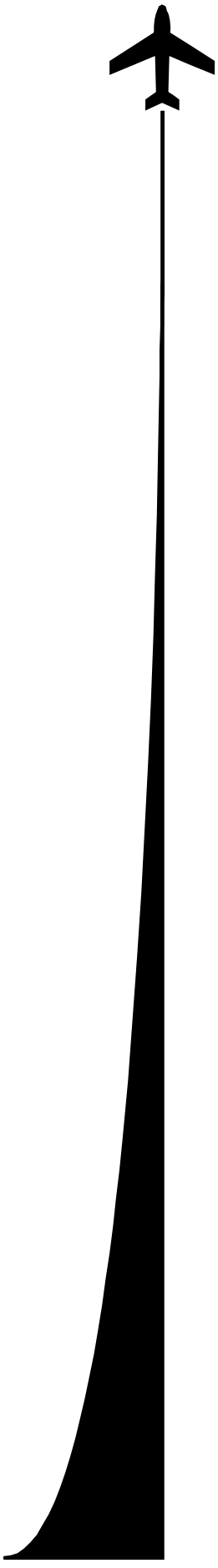

Session 5

Transport and Logistics System Modelling

THE APPLICATION OF A NEW ITERATIVE OD MATRIX ESTIMATION FOR URBAN PUBLIC TRANSPORT

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Keywords: public transport, OD matrix, matrix estimation, PTV-VISUM

The estimation of OD matrix is an "evergreen" topic especially in the field of public transport, due to the phenomenon that this is the key of the planning of public transport systems. On the other hand, it is one of the most important mosaic to the accurate prediction of the traffic load, or the correct execution of the planning stage assignment. This requires not only a well-functioning assignment method, but also reliable passenger data. Reliable passenger data means time-dependent origin-destination matrix. There is a lack of well working origin-destination matrix estimator method in the field of urban public transport.

The research team at the Széchenyi István University (Hungary) dealing with this topic for years (Winkler, 2011). There were several predecessor methods, e.g. one shown four years ago at TRA2010 (Horváth, 2010). Through the use of that method in the every day practice, it has been clear that the method can be used only if the network is simple without lot of transfers. Therefore in 2012 the group started a research in a new direction, based on an old model (Prileszky, 1995). The first test results of this research were shown at TRA 2014 (Horváth, 2014).

This paper shows the first real network results of the method used in Hungarian cities.

The newly developed method working with two kinds of input data: full scope cross-section data and a sample origin-destination matrix. These data will be used on one hand to produce multiplier to correct the sample origin-destination matrix, but on the other to help the calibration of the matrix. The method is an iterative method, which needs 20–50 steps to produce a reliable origin-destination matrix.

The paper describes the theory of the process and shows real network experiences.

Theory of the method is that origin traffic (boarding passengers) and destination traffic (alighting passengers) together with the link load of the public transport lines on each and every section (link) bears some information about the real origin-destination matrix. In the method we collect mentioned information for every origin-destination pair separately and multiply the elements of the sample network with a multiplier calculated from the above-mentioned information through a mathematical function.

The paper shows the effect of different mathematical functions using by the calculation of the multipliers on a test network. It is very interesting to see that in some cases even the simplest function can give good result.

Finally, a real public transport network will be shown to prove the effectiveness of the method. After this example the paper shows that the newly developed method is good enough to use in the real life work without any limitation like experienced with the old estimation method.

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MODELLING OF CONTAINER TRAINS IN THE STRUCTURE OF A DRY PORT WITH THE USE OF TECHNOLOGY "BLOCK-TRAIN"

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Keywords: simulation, dry port, "Block-Train" technology

The purpose of this study is to develop a simulation model of transport communication between the sea and rear container terminals for determination the mode of this unit and the necessary volume of railway rolling stock.

At this moment, the absolute majority of Russian seaports, which possess container terminals, have nearly completely exhausted their capacities (Kuznetsov, Eglit, Kirichenko, 2013).

One of the ways to solve the problems mentioned above is the commissioning and exploitation of rear terminals or, as they are called, "dry ports", which are located the city limits. First, these decisions have been applied in Western Europe in the middle of the last century with the purpose of cargo flows diversion from the destroyed port facilities. At this moment, the effectiveness of dry ports has already been proved both in the worldwide practice, and in Russia (Kirichenko, Kuznetsov, 2014). As the example one may take the terminal in Shushary, which is used as the rear platform for JSC "First Container Terminal".

The implementation of the "dry port" technology allows marine terminals to perform only transit or transshipment functions. The storage of goods during the customs' clearance as well as the consolidation operations is provided by the rear terminal. Thus, it can function as a distribution centre.

There is a need to determine the optimum amount of rolling stock to provide additional transport link and the subsequent optimisation of costs for the purchase or lease of rolling stock and its subsequent operation.

One of the existing methods to solve this problem is simulation. The research model was developed on the base of the "AnyLogic" software.

This product allows the user to create models with the help of the set of active elements that simulate real-world objects and experiments that define the configuration settings of the model.

The operational activity of any transport system may be represented as a chronological sequence of events. Modelling such a system relates to discrete modelling.

For modelling purposes the following factors were defined (Kirichenko, Kuznetsov, Izotov, 2013):

- Determination of the mode of operations for the transport unit;
- Determination of the number of the rolling stock required;
- Improving the "Block-Train" transportation technologies.

As a background information for the simulation the available statistic data on import cargo traffic between the "First Container Terminal" and a terminal in Shushary was selected, as well as the data on traffic conditions in the area "Avtovo railway station – Shushary railway station" of the October Railway.

The model considers the application of the "Block-Train" rail transportation technology, which implies the presence of the specially selected branch of train schedule and reducing the time of inspection at railway stations.

Current algorithm of the model is shaped by standardized units' available and configured settings or by means of the JAVA language.

The simulation period is limited to one minute. The accelerated mode of the model allows for a few minutes realizing the experiment for the period, corresponding to one calendar month.

The model visualization is occurring in 2D and 3D regimes, and allows the user to demonstrate the operation of this transport link. The simulation results are presented in numerical and graphical form.

Thus, the following data was obtained: the maximum throughput, related to specified constraints and probabilistic characteristics of the link, results in 134 40-foot shipping containers per diem in the import direction. The daily number of "Block-Train" trains is 2. To ensure the transportation of the cargo, it is necessary to rent or purchase 289 railway flatcars.

With use of the empirical stock factor in the case of failure, it is possible to determine the actual amount of the rolling stock required.

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MODELLING AS DECISION SUPPORT TOOL FOR SUSTAINABLE TRANSPORT SYSTEM PLANNING: CASE-STUDY OF RIGA

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Keywords: urban planning, decision making, transport project, ex-ante evaluation, modelling

Understanding transport system's state and behaviour in whole is the key factor in sustainable urban development and planning. This requires the flexible and usable methods and tools that can help to support decision-making in transport planning through possibility to test the alternatives, projects proposals in the frame of integrated assessment. From this point of view transport modelling is feasible solution, which could provide decision-makers with suitable data for assessment of alternatives during transport system development. The decision-making could be considered by strategic, tactical and operational levels. The types of transport models could be referenced to decision-making levels and classified by level of detail: macroscopic, mesoscopic and microscopic (Ortuzar, Willumsen, 2006). The work presents the advantages of using the all mentioned above types of transport modelling on ex-ante stage of transport planning project evaluation and shows it on concrete examples.

The work presents three case-studies and discusses the place of transport modelling in decision-making process on example of Riga city. The first case-study is related with modelling of standalone crossroads and estimation of crossroad development alternatives and concerns highway P133 and Ziemelu street intersection simulation and capacity estimation (TTI, 2012). The second example refers to modelling of significant fragment (more than 50 crossroads) of Riga city centre and estimation of possibility to organize the pedestrian area in the city centre (TTI, 2011). The last one is dedicated to estimation of possible rerouting solution of freight transport from Riga city centre (TTI, 2014).

The presented case-studies were developed by Laboratory of Applied Software Systems in Transport and Telecommunication Institute from 2011 to 2014 and are selected in a way to demonstrate how the modelling could be used on different decision-making levels.

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DATA ACTUALIZATION IN MODEL-DRIVEN DECISION SUPPORT SYSTEM FOR TRANSPORT SYSTEM PLANNING

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Keywords: urban transportation system, decision-making, microscopic model, credibility, regression model

The using of microscopic models repositories in model-driven decision-support system (DSS) allows one to get a comprehensive idea of the upcoming changes on the global and local level of urban transportation system (UTS) and assess the impact on their subsequent implementation, and as a result to improve decision-making by the responsible person (Barcelo, 1997; Ortuzar et al., 2006; Kergaye, 2010). Despite the obvious advantages the using of microscopic models as a part of DSS is poorly studied and they are rarely used due to the complexity of the model structure and its application, as well as high requirements to the data (Wood, 2012). Due to the fact that the main condition of transport models usage is the decision-making person's trust in modelling results, and taking into account that at the micro-level the traffic properties and UTS network configuration are changing faster than at macro-level, both the data in databases and the models in repositories are needed for a more frequent actualization and calibration in spite of macroscopic model application. That's why it is needed to propose the fast procedures for data actualisation.

The conception of regression models' (RM) application for data actualization needed for model-driven DSS is offered in this research. The decision-maker solving the problems of UTS planning can face with two typical situations of data absence. It is necessary to repeat the investigation of UTS fragment on the basis of a previously created simulation model and with preliminary knowledge about changed situation. In this case an additional UTS survey for the data updating is typical decision for model actualization and usually it is quite expensive and time-consuming. The second typical situation concerns the need to estimate the influence of new solutions on one TS fragment on the neighbouring. The researcher can have the microscopic models of considered UTS fragments, but he hasn't the possibility to connect them together to transmit the new volumes of traffic. The traditional solution of the highlighted problems is either expensive or it doesn't exist at all.

The authors proposed the RM application for data actualization and new obtaining, and considered several task settings for realization of such approach:

- the data actualisation for MM of UTS fragments that are on one street and on different ones;
- the data obtaining for analysis of new solutions' influence on the neighbouring fragments of UTS (both for UTS fragments located at the same level (road) and the different one).

The approach has been approved using the simulation model that was constructed in the frame of the project "Pedestrian and Transport Flows Analysis for Pedestrian Street Creation in Riga City" (Yatskiv et al., 2011). The offered procedures on the basis of regression models can be used in the frame of model-driven DSS and give the possibility to fulfil the process of model actualization faster and less expensive without loss of accuracy.

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THE USE OF MATHEMATICAL MODELS FOR LOGISTICS SYSTEMS ANALYSIS

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Keywords: mathematical models, logistics systems analysis

A mathematical model is a description of a system using mathematical concepts and language. The process of developing mathematical model is termed mathematical modelling. Mathematical models are used in logistics systems analysis. A model helps to explain a system, study the effects of different components, and make predictions about behaviour. Mathematical models can take forms such as dynamical systems, statistical methodologies, differential equations, queuing theory, mathematical programming, and others. Mathematical models can be divided into two types: analytical and simulation models. Analytical models are used, when the structure of the system is relatively uncomplicated and there exists analytical form in what systems structure can be written. Most of cases simulation models are used when the systems can't be written in an analytical way. Simulation is used to study situations characterized by uncertainty. Mathematical modelling gets more and more important for logistics systems analysis as systems gets complex and there is a need for a tool that helps to understand the systems and to give the desired answers to questions in time as short as possible.

There are literature sources that describe how mathematical models are applied for logistics systems analysis. Peruvemba (2005) gives a brief overview of mathematical problems in logistics. The last forty years have been very important in logistics development field, from its concentration on a company's physical processes to a holistic process and customer oriented management instrument. That also meant a continual change of the mathematical challenges in logistics (Möhring and Schenk, 2010).The importance of mathematical methods for logistics systems analysis confirms separate sections of international conferences or even ongoing individual conferences of this theme.

The International Symposium on Mathematics of Logistics took place at Tokyo University of Marine Science and Technology (2011), where scientists and practitioners had opportunities to attend lectures on theory and practices of mathematical methods of logistics. There are institutions that provide services for logistics performance improvements, for example, in Australia there is the Centre for Industrial Modelling and Optimisation (CIMO), which specialises in industry-focused research and training, it offers consulting services in applying optimisation, operations research and statistics to industries such as transport. There are many challenging optimisation problems in the design and operation of transport and logistics networks. The activities of the research are applied to vehicle routing and scheduling for long and short haul operations; optimal fleet sizing, composition, maintenance and replacement; optimal warehouse operations; supply chain management; and a wide range of logistics issues.

Daganzo (2005) in his book classified optimization methods to one-to-one distribution, one-to-many distribution, one-to-many distribution with transhipments, many-to-many distribution. Simchi-Levi et al. (2014) book focuses on the application of operational research and mathematical modelling techniques to logistics and supply chain management (SCM) problems. Takai (2009) mentioned that SCM problems are important because of structural changes in the nature of supply chains and more advanced functional requirements.

This paper will review the contributions of mathematics to logistics and illustrate how the use of new mathematical insights and procedures will ensure the potential for continued successes in logistics.

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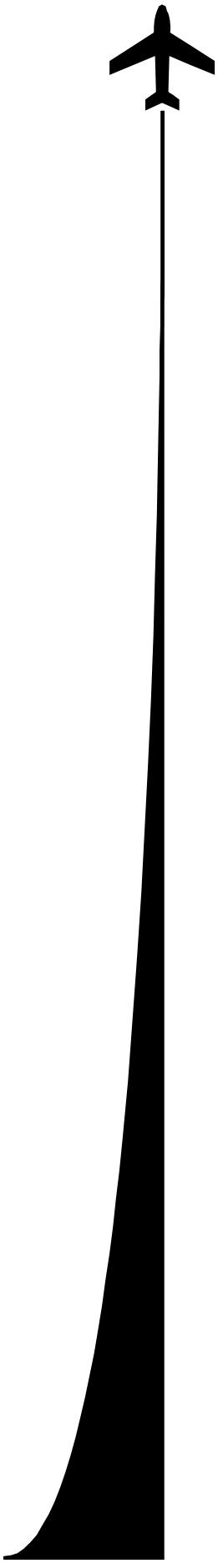

Session 6

Aviation

ROAD FEEDER SERVICES – "FLYING TRUCKS" CONCEPT AS AN ALTERNATIVE FOR THE DEVELOPMENT OF THE REGIONAL AIRPORTS IN THE BALTIC SEA REGION

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Keywords: air cargo, Road Feeder Services (RFS), regional airports, multimodality, air-road concept

Especially in the times of economic slowdown, the pace of change in the transport sector is increasing. In the total market of logistic services air cargo transport has very low volume, but a high revenue yield part. The growth of the airfreight is mostly driven by business internationalisation as well as decreasing air transport costs due to improving efficiency and strong competition among air carriers. Most regional airports in the BSR that act totally isolated, do not have a clear picture of the current situation on the international air cargo market, its future perspectives and sustainable development plans. Trying to meet the market demand, the regional airports are making huge and unjustified investments, e.g. improving airport infrastructure.

It is not clear till now, which elements of the Pan-Baltic cargo market could be managed as an alternative revenue yielding services for consolidated operation by air or what infrastructure is needed to provide the opportunity for an optimal economic mix of road-rail-air-sea transport?

Nowadays, to a large degree air cargo traffic relies on scheduled, frequent passenger services in hub-and-spoke as well as in point-to-point traffic. Regional airports are presently suffering from a lack of scheduled uplift capacity. The volume currently transported by air is almost entirely based on the occasional charter flights. However, the growth of the air cargo business is likely to be based not only on cargo charters, but to a larger extend on truck-based services for transit shipments. Onward transportation by truck may occur on road feeder service, so called "flying trucks", where a real truck substitutes a flight. "Flying trucks" are having flight numbers etc., therefore they must be prioritised in many ways in the BSR transport policy.

The paper investigates the possible role of Road Feeder Services, named here as "Flying Truck" concept as an opportunity for the development of the regional airports to be more actively involved in the global air cargo network.

USING THRUST-BASED SAFETY MARGIN OF GAS TURBINE ENGINE AS A CRITERION FOR ASSESSMENT ITS TECHNICAL STATE

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Keywords: gas turbine, diagnostics, reliability, engine characteristics, thermodynamic gas parameters, diagnostic mathematical models

Faults of gas path of gas turbine engine affect the change of thermodynamic gas parameters across the gas path of the engine and, accordingly, lead to changes in engine output parameters – first of all, the engine's thrust (Yunusov, Kopytov and Labendik, 2006).

To assess the kinds of technical state of an engine, thrust-based safety margin in engine operation has been proposed as an integral criterion for the assessment of engine's technical state. It was proposed to describe the possible technical states of engine by ranges of its thrust-based safety margin: ΔK_{R_1} – normal, ΔK_{R_2} – operable non-critical, ΔK_{R_3} – critical operable, ΔK_{R_4} – inoperable.

In terms of flight safety provision, the assessment of critical operable state is most important since the pilot must know whether he will be able to complete the flight in case of a fault of the engine.

However, it is impossible to make a direct measurement of flight thrust onboard the aircraft. Therefore, to determine the thrust created by the engine installed on aircraft, a certain operating parameter proportional to thrust should be measured. It is proposed to use fan air pressure ratio as a thrust level control parameter for turbofan jets. However, turbine exhaust pressure measurement is also desirable to diagnose the turbine operation.

Application of the laws of the theory of similarity can significantly reduce the amount of calculations of altitude and speed characteristics of engine based on the characteristics of its elements. It was proposed to present altitude and speed characteristics of aircraft engines in the form of a set of basic characteristics under the prop module similarity modes under the maximum reduced mode and a set of relative variations of parameters according to reduced throttle characteristic, using the change in fan air pressure boost as a throttle criterion. Therefore, the obtained general formula of bypass turbofan engine thrust in flight has an unambiguous and simple algebraic form of accounting a change in maximum thrust based on flight speed and altitude under similarity mode and throttle with respect to this maximum engine thrust.

A worn engine produces less thrust at a set rotor speed supported by engine ACS. This will lower the fan and compressor pressure ratio as well. However, constant thrust is required on the plane to maintain a given flight mode, thus the engine should have to be operated at elevated mode (implying higher rotation speed of compressor and fan).

Identification of the reason for thrust changes requires fault isolation along the gas path of engine, but it is an independent problem of diagnostics of technical state with respect to individual engine components.

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THE LITHIUM-ION BATTERIES OF BOEING 787 – ARE THEY ALREADY SAFE?

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Keywords: Boeing 787, lithium-ion batteries, overheating, aircraft orders, electrical system, APU

This paper deals with problems of Boeing 787 Dreamliner lithium-ion batteries. Several aircraft suffered from electrical system problems caused mainly by battery overheat and fire. These occurrences lead to full grounding of the entire Boeing 787 fleet, the first such grounding since that of DC-10s in 1979. At the beginning, the paper describes the 787´s batteries location and their utilization. The next part summarizes significant battery occurrences from the start of operations until present days. Occurrences of such magnitude place stress on aircraft manufacturer, which should flexibly fix design problems in the timeliest manner. Any delay in this process may lead to loss of customer interest and subsequent order cancellations or decreased number of future orders.

The last part of this paper deals with the perceived impact on Boeing 787 orders in the months following the Boeing 787 grounding due to outcomes of Japan Airlines B787 incident investigation. This is also supported by statistical analysis of orders. It is a big challenge for Boeing to improve its image due to mentioned problems and keep all customers satisfied. However, on 14th January 2014, 9 months after the B787 returned to service, a problem was discovered again during Japan Airlines Dreamliner maintenance.

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GLOBAL AIRLINE ALLIANCES MODELS

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Keywords: Global Airline Alliance, Route Network, Air Services Agreements, Network Effect

This paper deals with the issue of global airline alliances. According to Oum, Park and Zhang (2000) the basic division of alliances distinguishes between Complementary and Parallel alliances, however in practice all alliances are a mix of the two. Advantages of both and airlines' benefits resulting from membership in such an association are further discussed in the paper.

According to research it was only after cooperation in form of alliances or code-share were introduced that enabled provision of higher level services for travellers by for example flight schedule coordination that save the passenger their valuable time when changing or transferring flights. More importantly it enabled the alliance airlines to offer higher frequencies on their routes. This can be supported by an example where initially each of the partners offered one service on route from point A to B. After joining the alliance and signing a code-share agreement each of the partners continued to operate its route and at the same time it code-shared the additional connection of the partner. This effect is however influenced by multiple conditions resulting from the behaviour of travellers and airlines whose consequence is adjustment or modification of route structure after alliance entry. Hypothetically we can distinguish among four different patterns travellers adopt on route between individual points. Frequency of the route combined together with aforementioned four types of passenger behaviour means that there are four models that the alliance can adopt. Paper further analyses these traits and gives a well-organized outline of possible results in each individual case.

Conducted research also stresses the network element of the routes as a main benefit for the new member airlines. For many airlines the intention to enlarge its route network into more global scale is the foremost incentive to join an alliance.

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USING THE GNSS AT THE AIRPORT WITH UNDERDEVELOPED NAVIGATION INFRASTRUCTURE

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Keywords: GNSS, CAA, ANSPs, RNP, PBN, smallairports

This paper describes the consistent preview of the Global Navigation Satellite System (GNSS) at the small airports with underdeveloped navigation infrastructure.

The GNSS as a source of position information available worldwide is considered as a key enabler to this purpose. Following ICAO recommendations, the small airports and regional ANSPs are target stakeholder for the implementation of Performance Based Concepts (PBN). Most of European Aeronautical Navigation Service Providers (ANSPs) still do not have defined PBN implementation roadmap or PBN Implementation plans fully developed. There are a spectrum of reasons for this status, the knowledge capacity required by the ANSP's and the CAA staff being one of them. Better use of airspace, including its design, shaped upon PBN concepts and enormously increased situational awareness for both the flight crew and the ATCO, are considered as the key immediate safety benefits.

Demand for introducing new navigation applications in all flight phases is there, since most of airline operators are looking for the capabilities and services oriented to both the increase of efficiency and the reduce of the fuels. At this moment it seems that the actual requests by users on APV approaches operations are mainly focused on those operations enabled through Barometric guidance, the so-called APV BARO-VNAV, but things are moving fast and first formal demands of PBN concepts are being received by ANSP's.

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FLIGHT SIMULATION TRAINING DEVICE TERRAIN MODEL CREATION

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Keywords: laser, scanning, terrain, model, flight, simulation

The development of flight simulation training devices proceeds every year with newer and newer technological advancements, improving not only the possibilities of airplane behaviour and technical details fidelity, but also the immersion provided by the visual and audio systems. The goal is not only to provide the pilot all the required visual cues in order to perform the flight efficiently and to mimic the information provided by terrain, signs and lights, but also to make the pilot forget about the flight taking place in a simulator and make him react as in a real situation.

This can be achieved by creation of high resolution 3D model of terrain (Digital Terrain Model – DTM). This can be achieved by several ways, but most commonly by aerial sensing, meaning aerial photogrammetry and aerial laser scanning. The University of Žilina has obtained equipment for both ways of DTM creation, but this paper will mostly deal with laser scanning technologies.

The hilly terrain of the Slovak Republic brings challenges for terrain model creation, especially when using 3d laser scanning. Laser scanning tasks are flown relatively low above terrain in comparison to photogrammetric flights. This is due to low energy of laser-scanning equipment and correspondingly low range. The low flight altitude subsequently brings problems with coverage. The overlaps of LIDAR strips must be set very high, as the real coverage significantly decreases with increasing terrain undulation. As an example, overlap setting of 55% will provide coverage of only 15% when terrain elevation is 400 meters above the reference elevation. This problem is more exaggerated with increasing LIDAR resolution. The higher the resolution, the lower is the flight altitude because of laser scanning equipment capabilities.

This paper will provide information on technical possibilities to create detailed 3D models of terrain for flight simulation training devices, utilizing aerial photography and laser scanning of the surface. It will also provide overview of the equipment used by the University of Žilina and our initial experience with its operations.

Further it will show the methods we used to deal with the afore-mentioned problem of lateral overlap between LIDAR strips in hilly terrain and the terminal effect on cost effectiveness of laser scanning in comparison to flat terrain.

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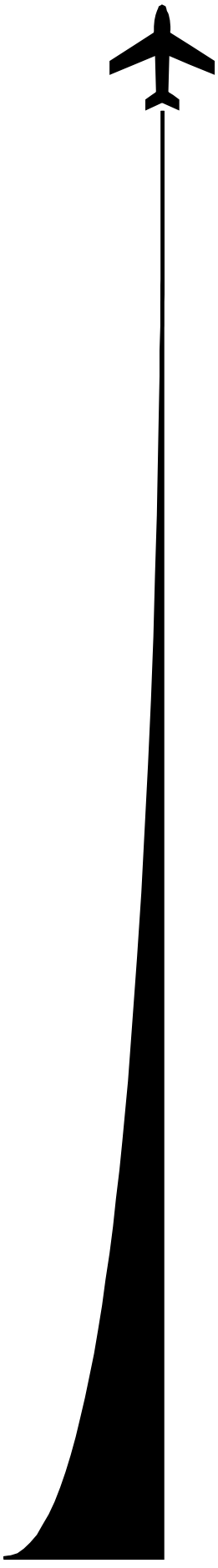

Session 7

RFID Applications for Transport and Logistics

UHF RFID TAG FOR UNDERWATER APPLICATIONS

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Keywords: UHF RFID tag, underwater identification, rfid technology

The article discusses the possibility of using UHF RFID technology in an atypical environment – underwater. Currently, there are a limited number of studies that have a focus on this topic, due to the known physical law of the propagation of UHF RFID waves in water. The given article does not aim to invalidate these laws, but outlines UHF RFID tag solutions that can be used in aquatic environments.

In the considered research there has been done analysis of factors that have influence on underwater propagation of electromagnetic wave and create an optimal model of UHF RFID antenna that is able to work in air and cover underwater communication (Severns, 2014; Shan & Georgakopoulos, 2011; Al-Shamma'a & Saman, 2004; et al.). As permittivity air is 1 and permittivity of fresh water is 80 (Shan & Georgakopoulos, 2011) it is clear that the target of our project has to be found in an compromise model of UHF RFID antenna.

The theoretical model of an UHF RFID antenna for different value of conductivity σ and relative dielectric constant ε was created by simulation software WIPL-D Pro (8). From all simulation the most suitable for underwater applications was a model, which was a base on a spiral antenna.

Prototypes based on chip Monza X 8K (Impinj Company, 2010) and chip EM4324 (Benelli et al., 2009) have been produced and successfully tested, confirming the theoretical conclusions set by previous studies. The results of the live measurements have been presented to RFID laboratory VSB-Ostrava.

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MUTUAL COEXISTENCE OF ACTIVE AND PASSIVE RFID TECHNOLOGY

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Keywords: RFID technology, active tag, passive tag, transport unit, identification

This article deals with research of mutual coexistence of active and passive RFID technology, which is a part of automatic identification and data capture. In this article we would like to describe an identification of transport unit based on passive technology and also by active technology. We would like to specify, how this technologies can work together and in which application focuses on postal and logistics. All results are verified by measurement in our AIDC laboratory, which is located at the University of Žilina. Our research contains different types of measurements in order to point out the possible influence of these two technologies. The results of our research bring the new point of view and indicate the ways using of UHF RFID technology in postal and logistics applications. At the end of this article the utilization of the RFID technology in postal logistics chain by using both passive and active technologies is characterized.

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THE USE OF RFID TECHNOLOGY TO IDENTIFY TRAFFIC SIGNS

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Keywords: RFID, road sing, security, transport processes, modeling of RSSI, transport vehicle, car register

This article deals with the possibility to identify traffic signs by means of RFID technology, the nature of the use (target utilization) is a diverse that can be used for diverse purposes. The introductory part of this post is about the way type and location of RFID identifier to any traffic sign, i.e. how effectively put RFID identifier to ensure the best possible level of readability of RFID identifier detainee at the road sign. An integral part of this article was the creation of appropriate measurement methodology to ensure high quality and comparable results. The following chapter consists of a description of measuring the readability of RFID identifier that you have placed on signs in laboratory conditions. The penultimate chapter depicts the results already obtained in the above measurements. Finally, the paper summarized the general lessons learned during the measurements and there are other possibilities of examining the readability of RFID identifier that you have placed on road signs by measuring very close to the real traffic.

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THE CORRECTION OF RFID IDENTIFIERS SCANNING ERRORS ON DYNAMICALLY MOVING LOGISTIC UNITS

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Keywords: dynamic movement, conveyor belt, logistic unit, radio frequency identification, tag

Current logistics, as well as its individual processes, either in manufacture or in processing and distribution of material and goods, are characterized by continual increase in demands as well as by change of the demanded and realized volumes of performance. This change means not only gradual increase in transport of goods and materials and in the amount of manipulations with logistic transport units, but also the change of dynamic and qualitative parameters of processing and distribution processes, such as speed, time, accuracy and reliability. Within the structure of individual processes of logistics chain, the improvement of the above-mentioned parameters depends mainly on implementation of new technologies, methods and procedures, which will be able to appropriately eliminate critical parts or bottlenecks in the chain. Bottlenecks in logistics chain are represented by particular machine, device or other factor, which in some way restrict manufacture processes and further processing.

The aim of the research presented in this paper is to find possible ways of corrections of errors and scanning of static RFID identifiers, which are located on dynamically moving logistic transport units. The main reason for examination of these issues and for its testing is looking for solutions, which will be able to improve current systems of automation and processing of consignments, goods and materials, increase in accuracy and reliability. Laboratory measurement will include simulated operation parameters of the real RFID gate, as well as machine equipment of the logistics chain, such as conveyor belt, pallet truck, and forklift truck. Combination of these devices and RFID gate, together with the need for performing scanning and identification of particular goods and material creates specific conditions for the formation of the bottleneck, which subsequently needs to be eliminated; or set the rules for its 100% use.

In the opening part of this paper, authors deal with determining theoretical base of the issue and with definition of particular conditions, under which the measurement takes place, as well as with the specification of technical equipment used in the research. There are decisive parameters of the measurement, which are the most important with respect to the dynamic nature of tag scanning, e.g. received signal strength indication (RSSI) value, error rate, speed of scanning tag/object with tag; number, position and the angle between scanning antennas. The tag placed on the object keeps its static position; however, it may change its orientation on the selected area. Thus, the overall measurement conditions correspond with the definition of ideal RFID system (Bolić, Simplot-Ryl and Stojmenović, 2010), using real operation parameters.

The core of the paper contains analysis of measurement progress, gained results and particular values and its comparison with hypothetical theses. Primarily, mutual dependence between RSSI values and the speed of tag movement is examined. Concluding part contains proposed possibilities of corrections of scanning errors, suggestions for improvement of practical system, and other achieved findings and conclusions.

In the recent years RFID technology came to the fore and in many cases replaced older identification technologies. Reduced technical and economic requirements enabled its better availability, as well as development of new hardware and software solutions and more opportunities in further research and use. The potential and possibilities of RFID technology always depend on current technical progress and development; therefore it would be useful to look for solutions, which could improve already implemented technology and its operation conditions without need of procuring a new one.

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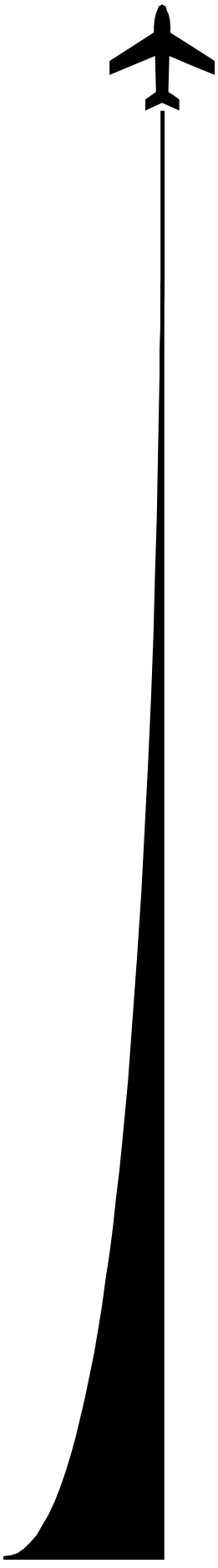

Session 8

Applications of Mathematical Methods to Logistics and Business

LATENT VARIABLES IN A PROBLEM OF RATING ESTIMATION

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Keywords: Rating Estimation, Matrix Factorization, SVD Decomposition, Alternating Least Squares, Netflix, FastrBooks

Let us consider a rectangular table of network rating. We will call one as $n \times m$ matrix *Y.* Rows correspond to users with order numbers $i = 1 \ldots n$, columns correspond to items with order numbers $j = 1 \ldots, m$. Matrix element $Y_{i,j}$ represents the rating score of items *j* rated by user *i*. A traditional problem is the following: it should be describing matrix *Y* by less dimensional: $Y = R^T + E$ where the left matrix *L* has *n* rows and $k < \min\{n, m\}$ columns, the right matrix *R* has *m* rows and $k < \min\{n, m\}$ columns, and *E* is a matrix of "errors". Each row of *L* represents one user, each row of *R* represents one item, and the *k* columns of both *L* and *R* represent *k* underlying latent (hidden) variables.

Traditional approach uses a method of least squares estimator: the sum $LSS = \sum_i \sum_j \left(Y_{i,j} - L_{i*} R_{j*}\right)^2$ must be minimized, where L_{i*} and R_{i*} are the *i*–th rows of matrices *L* and *R*.

It happened so because of some values of value $Y_{i,j}$ are missing. In many recommendation systems, the task is to estimate some of the missing values in Y based on the known values.

Various aspects of this problem are considered in our paper: computational, statistical and practical ones. Given results are based on real-world Netflix Prize and FastrBooks datasets and used for improvement of user-engagement ratio.

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USING OF THE ALGORITHM OF ARTIFICIAL IMMUNE SYSTEMS FOR ADAPTIVE MANAGEMENT AT CROSSROADS

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Keywords: traffic light, adaptive control, artificial immune systems

Artificial immune system (AIS) is a class of intelligent automated systems using the principles of the immune system (Fogel, 2000). Artificial immune system – an adaptive computing system, using models, principles, mechanisms and functions described in theoretical immunology, which are used to solve applied problems. The immune system is of great interest to experts in computer science as it is an example of powerful and flexible decentralized information processing (De Castro, 2002).

The immune system has all the main features of artificial intelligence: memory, ability to learn, the ability to recognize and make a decision as to how to deal with unknown code, entered the body (Dasgupta, 2006). Like artificial neural networks, AIS can accumulate new information and using a preliminary study of information, perform pattern recognition in a decentralized manner. Along with other systems of organism it supports sustainable state of vital functions, called homeostasis.

AIS perform a targeted search of the local extremum, combined with the ability to search the global extremum. A method for finding the optimal solution based on the use of operators clonal selection, mutation and negative selection. Each of the estimated measures of fitness of antibodies according to how "good" the corresponding solution of the problem. Most appropriate antibodies are able to "reproduce" with the help of hyper-mutation. This leads to the appearance of new antibodies that during hyper-mutation improve its compliance with the fitness function. Antibodies with the worst affinity are replaced by randomly generated elements, uniformly distributed over whole domain of definition the target function that allows to not close on local extremes, and to explore the entire space of the domain of definition target function. Thus, there is an iterative process of reproduction of new populations of the best representatives of the previous generations. Each new generation has a higher ratio of characteristics that best members of previous generations.

To check the work of the algorithm to adapt the model of the crossroads was created. Structure is designed for cycle traffic light signalling rigid modes control. Simulation results at the crossroads demonstrated, that the average queuing time at the crossroads decreased by 62% during the test, and average queue length reduced by 47%.

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MODELLING OF SPATIAL EFFECTS IN TRANSPORT EFFICIENCY: THE 'SPFRONTIER' MODULE OF 'R' SOFTWARE

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Keywords: spatial effects, efficiency, stochastic frontier, R

The importance of spatial effects is widely acknowledged in different areas of transport science. Spatial relationships take a place in national, regional, and less aggregated levels. Transport infrastructure has significant spatial spillovers on regional industry, agriculture, and overall regional economic and social development (Tong et al., 2013; Cohen, 2010). Public transport routes and movements are an essential part of urban spatial planning. Spatial efficiency is a modern concept, frequently used in economic geography (Bapat, 2006).

Spatial econometrics (Anselin, 1988) provides an extensive set of tools for modelling different spatial effects. Spatial effects include relationships between neighbour units (e.g. spatial competition) and spatial heterogeneity (influence of area-specific factors like climate, economics, and others).

Stochastic frontier model (Kumbhakar & Lovell, 2003) is one of the most popular tools for statistical estimation of units' efficiency. Recently significant research efforts have been made to introduce spatial effects in stochastic frontier (Druska & Horrace, 2004; Affuso, 2010; Barrios & Lavado, 2010).

Estimation of spatial effects is quite complicated both from the theoretical and the technical point of view. This complexity is a serious obstacle for inclusion of spatial effects into everyday work of economists and urban managers. A stable and convenient software tool can bridge this gap for practitioners. The "spfrontier" tool is one of the first steps in this direction. "Spfrontier" is implemented as a module for CRAN R, a free software environment for statistical computing and graphics. Nowadays R is one of the most popular research data analysis tool, thanks to its extensive archive of modules and open source codes under GNU licence. The module is developed by the author, so the main goal of this research is to introduce the module to scientific community and investigate its facilities for modelling of efficiency in transport science and adjacent research areas.

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WEIGHTING THE URBAN PUBLIC TRANSPORT QUALITY INDEX ON BASE OF DIFFERENT APPROACHES

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Keywords: public transport, service quality, composite indicator, weights, comparing, analysis

Sustainable functioning of an urban transport system (UPTS) is one of the indicators of quality of life. Public transport should become part of a solution for sustainable transport. In order to keep and attract more passengers, public transport must to have high service quality to satisfy and fulfil more wide range of different customer's needs (Oliver, 1980; Anable, 2005). The development of a high-quality urban public transport system (UPTS) meeting the requirements of cities' residents is a key concern of the city development. An implementation of an effective management of the UPTS service and the development of measures to improve the UPTS services quality, satisfying consumers, requires an objective assessment of the level of quality. Therefore, issues of improving quality assessment of UPTS services allowing determining the level of UPTS service quality in whole are relevant.

The problem of estimating the quality of UPTS service is multidimensional if consider it in terms of data, because UPTS service quality is characterized by large number of indicators (European Union, 2002). For summarizing these multidimensional issues, the composite indicator is used. The authors investigates the problem of constructing the Urban Public Transport system service Quality Index (UPTQI) based on a composite indicator and the problems arising from it in their previous works (Yatskiv, 2010, 2011; Pticina, 2011). The methodology of composite indicator constructions based on the ten-step algorithm, which was developed, by the Organization of Economic Cooperation and Development (OECD) (Nardo, 2008) for UPTQI construction are used. One of the important stages in the construction of such index is weighting estimation. There are suggested the different weighting methods, which are derived from statistical models and from participatory methods as showed on Figure 1 (Nardo, 2008).

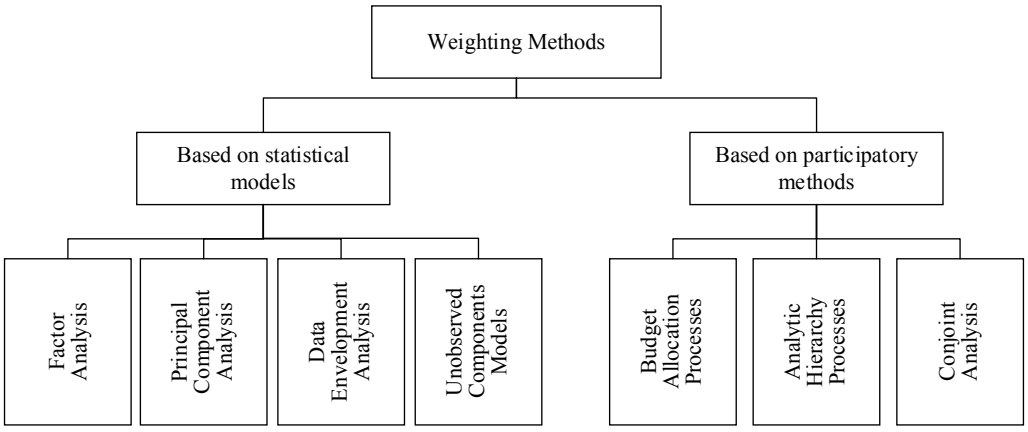

Figure 1. Weighting methods in composite indicator development

In this research the following methods are selected for comparing:

- based on statistical models:
  - Principal Components Analysis (PCA)
  - Benefit of the Doubt approach (BOD)
- participatory method: based on the AHP approach
- Equal Weighting (EW).

The results of these methods applying and their comparative analysis are presented. The UPTQI for 62 European cities were estimated. Data of eight UPTS quality indicators from the EUROSTAT database (EUROSTAT, 2014) are used as the sub-indicators values.

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CORRUPTION EFFECTS WITHIN DIFFERENT SOCIAL SYSTEMS

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Keywords: corruption, social model, regression, macro indicators

In common sense World Bank defines corruption as an abuse of public office power for private gains (World Bank, 2007). The problem of corruption is common for all countries, since they have the situation of opposing private interests and power of authority.

Corruption is a result of inefficiency of management or wrong public relations and creates new problems in these areas. As a result the world faces the expansion of existing and appearance of new forms of corruption. The defects of management usually give birth to new defects. Corruption has become an institutional trap. People suppose that the cost of corruption is lower than the price of fighting it. As a result, many countries condemn the corruption in word, but can do nothing in fact (Weder, 2002).

The social sphere presents the clash of interest of population and officials in all countries and is the most susceptible to corruption (Rogers, 2008; Blackburn. et al., 2006; Haque & Knellar, 2007). Corruption forms the wrong economic relations violating the fundamental laws of economic development. The level of corruption is different in all countries. It is impossible to determine the level of corruption according to the economic development of the country, for example, corruption in Uruguay is lower than in France (TI, 2012).

There are numerous researchers developing the relationships between corruption and other factors but there are practically no researches devoted to describing corruption in the terms of social models. The research goal is to discover the impact of corruption on indicators grouped according to the social model adopted within the country.

There are four social models, functioning on the territory of the European Union; nevertheless, only two of them, Continental and Scandinavian, are the objects of current research (Strelchonok & Popova, 2012a, 2012b; Popova, 2013).

The methods of qualitative content analysis, grouping, comparison and analysing have been used for determining the social models and the factors, which are significant and determining for these models.

The empirical analysis is based on the Corruption Perception Index (CPI) compiled by Transparency International (TI). The research has shown that countries with different social models present different dependence between corruption and other factors of social system. The importance of corruption for development of social system is supported by many other researches.

The countries grouped according to the social model have different dependences between corruption and macro indicators, the types of regression are different, and the quality of models is also different. For example, Table 1 below presents the indicators for which corruption is a significant factor (Popova, Podolyakina, 2014):

Table 1. Factors of economic development for which the factor Corruption is significant

Continental I (rich countries)	**Continental II (poor countries)**	**Scandinavian**
Resource Productivity	Resource Productivity	Growth Rate
Development assistance	Development assistance	R&D Expenditures
Exchange rate	Share of export	
Share of export	Level of poverty	
Level of poverty		

As it is seen in the table, countries of Continental model without any regard to their wealth (measured by GDP per capita indicator) demonstrate actually the same parameters; it is worth mentioning that in economic models they function independently. At the same time the Corruption has an impact on absolutely different factors in Scandinavian model.

The novelty of the research is a division of the countries according to the adopted social model; the obtained results have supported this approach. The practical implementation of the research results is possible via working out the set of procedures for fighting the corruption according to the social model.

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DEDICATED HARDWARE IMPLEMENTATION OFKECCAK HASH ALGORITHM FOR IMPROVING SECURITY IN DATA PROCESSING

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Keywords: SHA standard, FPGA, configurable hardware, automatic hardware implementation.

Security issues are one of the most important problems that define reliability of operation in contemporary Complex Information Systems (CIS) and, practically, in all other technical systems, which are backed-up with computer-based information infrastructure. Ensuring required level of information security and confidentiality constitutes very important challenge, which calls for application of appropriate cryptographic methods. This paper relates to one class of such methods, which are based on the so-called *hash functions*: we present hardware implementations of the essential component of the new SHA-3 hash algorithm – the Keccak-*f*[400] permutation function – in the total of 6 high speed organizations built around the concepts of loop unrolling and pipelining. All the architectures are implemented in two chips from popular FPGA families: the well-established Spartan-3 and the newer Spartan-6, thus we present a consistent base not only for evaluation of the various concepts of hardware implementations but also for comparison how the Keccak's specifics are handled by the implementation tools when the older versus the newer FPGA arrays are used.

In Keccak-*f*, as in any other round-based cipher of this kind, taking as the starting point the plain iterative organization (one round implemented in hardware and transformation of the state data consisted in a loop of 20 iterations) the two opposing techniques can be used to create various derivate architectures with different area vs. speed trade-offs: loop unrolling or round folding. Additionally, each of these techniques can be enhanced with pipelining (i.e. with splitting long combinational propagation paths by extra registers) if there is a cascade of combinational modules and multiple data blocks can be processed in parallel. In this work we have chosen to investigate 6 representative and most interesting organizations: the basic iterative one (denoted as x1), three unrolled ones with 2, 4, and 10 rounds implemented in hardware (x2, x4, x10), purely combinational, i.e. fully unrolled one (x20) and fully unrolled pipelined one (PPL20).

Upon expression of all Keccak round transformations in VHDL language at the RTL level, all the architectures are expressed as combinations of instances of the basic round module with appropriate (and, in all cases, relatively simple) control logic. It was chosen to develop an original VHDL implementation of the algorithm, which is more concise and easier in management when compared to the official implementation published by the authors of the method, and the result is equally efficient in both the speed and the size, as we have tested. Then, the designs are automatically synthesized and implemented for the two devices: Spartan-3 and -6.

Figure 1 presents parameters of the implemented designs as ratios of actual vs. predicted values (the prediction has been made from performance of the basic x1 iterative architectures) and it allows to evaluate implementation efficiency of unrolling and pipelining techniques. The results illustrate difficulties, which the new Keccak algorithm may create in automatic implementation in the Spartan-6 device. The trend in development of the FPGA arrays is towards more complex logic blocks, which are capable of implementation of more and more involved combinational functions, but the progress in the routing resources is not as considerable. While the optimization

techniques can reduce size of the unrolled Keccak loop on both platforms, routing congestion significantly impedes performance parameters in Spartan-6 up to the point where, for x20 variant, the older (and generally considerably slower) Spartan-3 device offers faster processing speed.

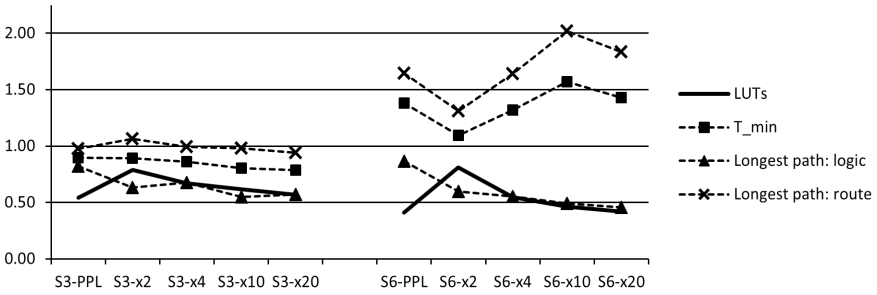

Figure 1. Parameters of the Spartan-3 (left) and Spartan-6 (right) implementations related to the values predicted from the reference x1 architectures

UTILISATION OF SELECTED MATHEMATICAL FUNCTIONS FOR SOME METAL OIL DATA EVALUATION

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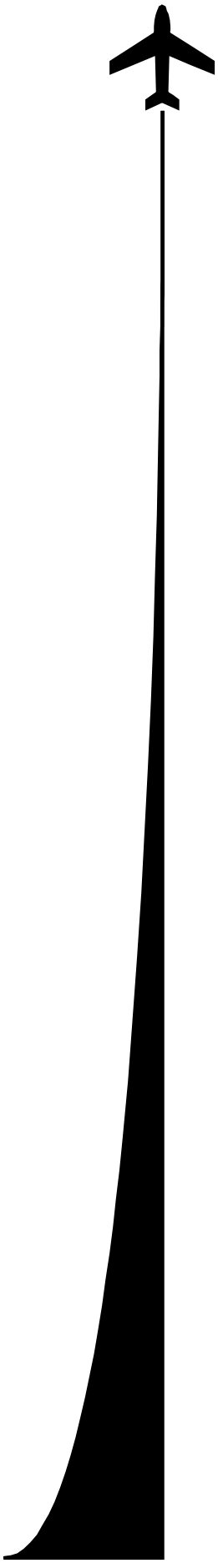
Keywords: field data assessment, off-line diagnostics, first hitting time, residual life, maintenance optimization

The paper deals with application of selected mathematical–statistical methods for analysing field data from heavy off-road military vehicles. We apply selected regression functions for description of the oil particles generation. The reason is to find suitable and predictable behaviour of the particles. This helps for creating the picture of the system – vehicle in our case – operational behaviour.

It is the vehicle engine and its metal – copper – oil data, which are explored for further utilisation. The pieces of information from the engine oil are interpreted in form of deteriorated oil characteristics (like changed viscosity, decreasing additives like Mn, Si, Zn, etc.) and polluting particles in oil (e.g. particles from wear process like Fe, Pb, Cu, etc.). As some particles are created due to the system degradation – mechanical deterioration some are inherently in the oil and degrade thank to the time elapse. Both of them create interesting picture of the oil physical properties, system properties and the history of operational conditions. These pieces of information have good technical and analytical potential. However they are not always used for system condition determination therefore has not been explored well yet. Thanks to well working the diagnostics there are the data collected in some fields but never calculated and used of estimation neither prediction.

There is – for us – available reasonable set of vehicles and their oil data from in-field-operation. The data create interesting sets/clusters which very likely describe system behaviour and oil condition. Since they are distributed into several areas we will investigate their information potential both separately and also jointly. Based on the data we assume it will be possible to propose and determine changes in the further system operation as well as we think the principles for maintenance optimisation may also benefit from the results. We apply and will present methods of multi-variate and multi-shape regression analysis to model the metal – Cu – data and provide outcomes + estimations for system operation so far and also for system further operation.

The novelty is to providing inputs for helping to change e.g. the cost optimisation, system maintenance policy, system operation and mission planning. Further development of our outcomes will be provided using other mathematical methods like fuzzy logic and diffusion processes.



Session 9

IT Applications for Transport and Logistics

MULTI-CRITERIA ANALYSIS AND CHOICE OF TRANSFERABLE GOOD PRACTICE ON INFORMATION SERVICES FOR IMPLEMENTATION IN THE SPECIFIED URBAN PUBLIC TRANSPORT SYSTEM

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Keywords: public transport, information service, transferable practice, multiple-criteria analysis, SWOT analisys

The development of passenger information services is one of the foreground tasks of needs gratification of today's mobile society. Currently, the countries of European Union (EU) have accumulated meaningful experience in information systems applications in public transport, first of all in passenger information, trip planning, ticket sales and reservation, traffic management, fleet management, etc. To disseminate the best practices on the information services in the public transport systems a variety of studies on comparative assessment of good practices and their implementation in different regions and cities are carried out.

In the framework of the international project POLITE a methodology of analysis and choice of good practices on infomobility services has been developed. The suggested approach uses 10 criteria that are classified into the following 4 groups: organization and legislation, infrastructural actions, information actions, and modelling (Yatskiv et al., 2013). For the good practices comparative assessment the authors have suggested the AHP (Analytic Hierarchy Process) method. The AHP method has been applied for assessment and choice of 32 good practices on infomobility services classified in the five groups.

For each of these groups the best practices with the highest priority (the weight of integral criterion) were identified. These practices were recommended to use both for the study of their experience, and for implementation in EU cities and regions (Yatskiv, Kopytov and Gorky, 2014).

The present study is an improvement of the suggested approach and takes into account more specific features of the region for which transferable practice has to be selected. The authors' propose is to include a SWOT analysis (Jenster and Hussey, 2001) in the assessment procedure and use it in conjunction with the classical methods of multi-criteria analysis. The SWOT analysis method allows determining a system of indicators that characterizes the public transport system of the investigated region. Then, the obtained indicators are included in the system of criteria characterizing good practice efficiency. To perform the calculations of criteria the standard algorithms of the AHP and Analytic Network Process (ANP) methods are used (Saaty, 2001, 2005). Inclusion of the second ANP method in the good practices assessment procedure allows enhancing the sensitivity of estimates in cases, when equivalent practices are compared.

As an example, the task of good practice choice for implementation in the public transport system of Riga city is solved. Using a SWOT analysis, the system of criteria that take into account the specifics of passenger traffic in Riga is developed. The results of the good practices evaluations using AHP and ANP methods allow finding the transferable practice, which has the highest value in priority vector (Saaty, 2001). This practice is recommended to be implemented in Riga city.

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THE PERFORMANCE ANALYSIS OF WIFI DATA NETWORKS USED IN AUTOMATION SYSTEMS

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Keywords: WiFi, 802.11, network simulation, bandwidth, network latency

Wireless Local Area Networks (WLAN) based on 802.11a/b/g/n technologies (often called as WiFi) has become quite popular and widespread. The nature of links based on the radio channel and the access to the shared resource of this channel cause variable available bandwidth, variable packet delay and loss rate. This may prevent to the correct operation of the networked time-sensitive applications, such as multimedia or control applications.

In the automation area, there is a clear trend promoting the use of wireless control channels in the factory floor. Closing control loops over wireless networks is raising interest also in the automation systems of moving objects. As an example of such system is a wireless electric recharge of driving vehicles (Gordyushins, Saltanovs, et al., 2013). For successful operation it is necessary to organize multiple streams of data between modules that transmit and receive energy. For DataStream providing system operating frequency synchronization high demands are formulated for the data channel delay time. In the wireless links of the system high levels of electromagnetic interference is expected and communication media must provide multiple access opportunities for communication with multiple vehicles.

It is known that the delay introduced by the network may degrade control performance or just make such control quite impossible. Therefore, a good estimation of the network bandwidth together with network latency will facilitate robust system designs.

In this paper the performances of WiFi network with infrastructure architecture have been investigated by using different applications data rate on transport layer (UDP was a transport protocol). In this investigation two or more WiFi hosts have been located in a single BSS area.

The network was simulated via NetSim (NetSim v. 6.1, 2013) simulation environment. The statistical data, namely, the statistical parameter of total application data (payload) delivered to their respective destination every second, characteristics of link latency (Queuing Delay, Medium Access Time, Transmission Time) and others have been collected from the simulations. In different numeric experiments payload, wireless technologies (802.11 a/b/g), distances between hosts and access point (AP), physical layer radio link characteristics were changeable.

As a simple result for automation control systems design on the basis of WiFi structures it was shown that under just “ideal” conditions (only one data flow in one direction and row bit rate in wireless link of order 54Mbit/s) only in limited range of application traffic from several Kbit/s till 10 Mbit/s the application packets delay would be of order 0.3 ms. When the traffic exceeds 10 Mbit/s the delay dramatically increases.

By comparing data from simulation experiments some recommendations are made for choosing appropriate configuration parameters of WiFi networks to achieve satisfactory relationship between bandwidth and packet delay for the automation control application.

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INCREASING RELIABILITY OF INTERNET-BASED COMMUNICATIONS BY MEANS OF IP SPOOFING PREVENTION

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Keywords: IP-addressing, IP-spoofing, DOS, gateway

Reliability of modern computer-based communications systems depends largely on the ability of a communication's model to resist external attacks on the computer system. The vast majority of attacks of various types in different stages of preparation and implementation of attacks use sender's IP-address spoofing. There are several reasons why the attacker spoofs the sender's address, including, for instance, the address of the victim during the attack (as for example TCP SYN-Flood). Equally, it is important for the attacker to hide the information about the true source (address) of attack.

In order to increase the capacity to withstand external attacks, which use IP-spoofing, the present work proposes a modification of IP-addressing called "asymmetric addressing". It has no significant effect on existing parameters of the IPv4 protocol header.

The border router (gateway) is "obliged" to paste into any outgoing IP-packet their IPv4 Gateway Address (GA), and attacker cannot interfere with this process. The "stamp", in fact, completely solves the problem of IP-spoofing, as GA represents the address of the sender.

Of course, such a "stamp" cannot guarantee the attacker identification, but the search of attackers location with different kind of software and IDS statistical analysis systems will be explicitly bound to one provider, and this will greatly facilitate and speed up the localization of both the attacker and its infected zombies.

In fact, it is about introducing in IPv4-addressing some minimal hierarchy using the 17^{-th} bit in IPv4 header. This bit in accordance with all current RFC is not used at all and has default value 0. Therefore it is proposed "to show" the availability of GA field just behind the standard of 20 bytes length, setting this bit to 1 as a sign of "asymmetric addressing". As a result the standard header length will increase by only 4 bytes, which is quite acceptable from the point of view of IP-packet traffic increase.

Why addressing is named as asymmetric? In a client/server model, the IP-addresses in the header of an IP-packet, both the client and the server are the same in field's number and their meaning. There are always two fields – the address of the recipient and the address of the sender.

In the proposed addressing system client addressing field configuration and the server are different. On the client's side, IPv4 header now requires three fields:

- the address of the recipient (the server);
- the field for border router address;
- and the client host address in the local network.

Server side addressing does not allow inserting in the outgoing packet header the gateway address because that would increase the number of addressing fields up to four. But the logic of the client/server interaction allows us to avoid this, and leave in the outgoing (from the server) IP-packet header the same 3 fields, but with some slight modification.

The proposed system IPv4 addressing has many obvious advantages.

Firstly, it excludes the possibility of IP-spoofing and the numerous attacks based on it (such as DOS (DrDOS)), meaning – it improves reliability of the communication systems.

Secondly, the development of IDS-systems and methods for locating the attacker is greatly simplified.

Thirdly, the usage of NAT-systems can be avoided, which accelerates local client's hosts performance, that have the "grey IP-addresses".

Fourthly, the proposed addressing system is optional, and can coexist with the traditional system of addressing.

Lastly, the new addressing system can enable protocol IPv4 successfully coexist with IPv6 protocol.

DOMAIN-SPECIFIC SOFTWARE ARCHITECTURE OPTIMISATION FOR LOGISTICS AND TRANSPORT APPLICATIONS

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Keywords: domain-driven architecture, domain-specific software architecture, architecture efficiency metrics, logistics and transport software.

Architectural and detailed design of modern logistics and transport software has a huge impact on a quality and cost of the development process, hence it's required to pay reasonable attention while making architectural and design decisions. The formation of architecture is the first and fundamental step in the designing process that provides the framework of a software system, which can perform the full range of detailed requirements (Orlov and Tsilker, 2012; Bass et al., 2013).

As long as there is no any universal method for building architecture, it is necessary to create a technique that allows evaluating the quality of architecture for logistics and transport systems.

The initial stage of this technique requires us to divide all kind of software systems to domains. Since the software for one domain have a significant number of similar characteristics and functional requirements, the software architecture for such systems also have similar requirements. In our case, we have logistics and transport domains, which could be divided to subdomains, including supply chain management systems, traffic control systems, etc. It's obviously that various supply chain management systems should contain a similar functionality, so we can pick up the base structure and common components of the architecture for such systems.

To construct a domain model and perform a domain analysis we can apply a set of principles used in domain-driven design (Evans, 2003) and domain specific software engineering (Taylor et al., 2009). The resulting domain model should include the following items: domain dictionary, information model, feature model and operational model. After that we should transform the obtained domain model to a reference architecture and component library.

The selection of reference architecture could be reduced to choice of architectural pattern. Depending on the specified requirements we can choose, for example, multi-tier architecture or service-oriented architecture. Also the reference architecture could be represented in terms of a specific set of components.

For the role of reference architecture for logistics and transport systems we choose a multi-tier architecture as this is most commonly used architecture style for such software systems (Orlov and Vishnyakov, 2013). The component library could contain patterns that are used for enterprise applications (Fowler, 2002). In addition to enterprise patterns we can consider various frameworks, since they include the implementation of a pattern or patterns' groups.

Domain-driven design and domain-specific software engineering methodologies are not well formalized. Also they lack metric suites for evaluation of architecture's quality. Therefore, when constructing architecture for logistics and transport systems we need to apply a modified technique of optimal pattern's suite selection (Orlov and Vishnyakov, 2012, 2013), which allows evaluating the quality of the created domain-specific software architecture.

At the final stage, the modified methodology of the selection of an optimal pattern suite allows us to fulfil the reference architecture with frameworks and patterns from the component

library. The task of choosing the pseudo-optimal pattern suite (for construction final architecture of the reference architecture) is reduced to the classical problem of integer programming where pattern-efficiency metric is used to evaluate influence of every considered pattern. This metric indirectly measures the functional complexity of software as well as inner and outer relationship of its components (Orlov and Vishnyakov, 2013).

After applying this technique we obtained the final architecture that is pseudo-optimal according to the architecture-efficiency criteria, also it meets the requirements for specified software system.

In this paper the technique that allows creating domain-specific software architecture for logistics and transport software is proposed. This domain-specific software architecture construction is reduced to the classical problem of integer programming where the optimal solution should be found. The results allow us making conclusions about usefulness of the proposed technique during architecture design phase for transport and logistics software.

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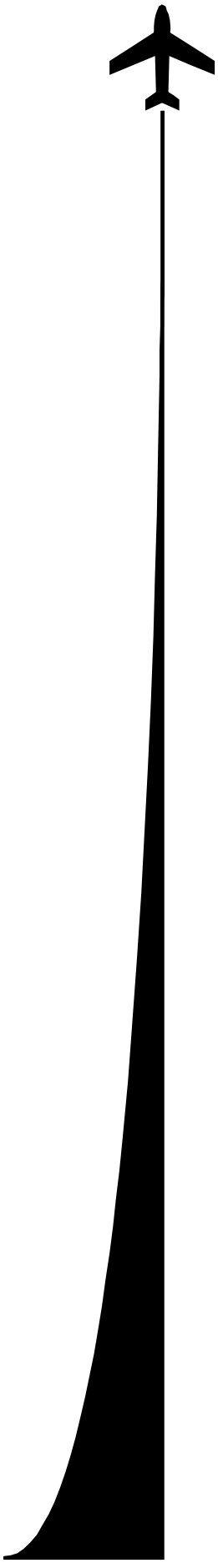

Workshop

LogOnTrain

ENSURE COMPETENCE IN LEARNING "BLUE COLLARS" SPECIALISTS

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Keywords: logistics, training, increasing the competence

If to compare the society with a human body, the transport industry is the circulatory system of modern society. According to the statistics, the amount of the international traffic grows from year to year. Thereby ensuring a high level of competence of logistic specialists, working in this field becomes important. The specialist has to understand not only the features of organizing the transportation in a particular country or region – for example, between the countries of European Union (EU), but also in other countries, which are not members of the EU.

As a part of the international project Logistics and Overland Transport Network for Training "Blue Collars" (LogOnTrain) studies of existing training programs for specialists of different levels of transport logistics had been conducted. In the course of project realization some problems were identified in the system of preparing specialists of transport logistics (particularly lower-level experts, the so-called "Blue Collars"). One of the problems is that training programs are not fully considering the features of transport legislation of neighboring countries. This is especially relevant for cross-border European Union countries – Customs Union: such as Latvia, Estonia, Russia and Belarus.

As part of the project a set of recommendations was developed to improve the quality of training specialists. In the first stage of practical implementation of the recommendations was the development of a series of manuals, which allows unifying knowledge and competence of specialist considering the modern requirements.

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THE NECESSITY FOR LIFELONG LEARNING IN TRANSPORT SPECIALTIES

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Keywords: Logistics, transportation, competence of specialists.

The dimension of logistics services (especially in the field of transport logistics) is one of the fastest-paced and dynamically changing economic areas. In this regard, there is a clear need for continuous improvement of knowledge of professionals in this field at all levels – particularly in dealing with international transit. This is primarily associated with the different requirements for expert competences and differences in the regulatory framework of the European Union (EU) and the Customs Union (CU) countries.

Within the framework of the international project Logistics and Overland Transport Network for Training "Blue Collars" (LogOnTrain) a valuable experience in synchronization of the requirements for training of specialists of different qualifications in transport logistics has been acquired.

As studies have shown, training of the mid-level professionals (fifth professional level), i.e. "Blue Collars", is the most problematic. There are several successful training programmes currently implemented in the Baltic States:

- lower level specialists – with the special secondary education (for example, at the Valga County Voc Training Centre);
- specialists with the higher education (for example, at the Transport and Telecommunication Institute – professional bachelor's and master's programmes).

Experience shows (judging by the employer reviews) that the established training and education system presents a number of flaws, and specifically:

- lack of the training system for the mid-level specialists;
- insufficient harmonisation of the training programmes between the EU and CU countries;
- limited possibilities for further knowledge building after completing either professional or academic education.

Within the framework of this project, a set of recommendations has been developed, facilitating implementation of the lifelong learning programme in accordance with the principle: professional school – college - graduate school – post-graduate education (improving the professional competence in a particular area of logistics).

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