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Proceedings of special session in Young Researchers' Seminars during the 17th International Conference on Reliability and Statistics in Transportation and Communication

alliance

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LIST OF ABBREVIATIONS

Abbreviation	Description
RelStat'17	17th International Conference on Reliability and Statistics in Transportation and Communication
Fraunhofer IFF	Fraunhofer Institute for Factory Operation and Automation
GA	Grant Agreement
ICT	Information and Communications Technology
TTI	Transport and Telecommunication Institute
UTH	University of Thessaly
YRS	Young Researchers Seminar
WP	Work Package

ABSTRACT

The deliverable presents the proceedings of the Young Researchers' Seminar – special session "Sustainable Transport Interchanges" in the framework of the 17th International Conference on Reliability and Statistics in Transportation and Communication (Riga, Latvia, 18-21 October 2017). During the Seminar, more than sixteen young researchers from Latvia, Germany, Greece and other countries participated, and, eleven presentations were made. As a result, eleven abstracts were included in the proceedings of the Young Researchers' Seminar.

1 Introduction

1.1 Content of the deliverable

The current document is a deliverable in the framework of WP3. The objective of WP3 is to define and implement a knowledge-sharing strategy. The strategy clearly defines the activities and plans for activities execution, which can maximize the transfer of knowledge between partners of the project. Knowledge-sharing strategy targets on the following groups of users: researchers and academic staff of TTI; master and PhD students. Deliverable D3.7 is a compilation of the abstracts and presentations made in Young Researchers' Seminar “Sustainable Transport Interchanges” during the 17th International Conference on Reliability and Statistics in Transportation and Communication by the young researchers from TTI, UTH and Fraunhofer IFF.

Abstracts and papers were submitted from TTI, UTH, Fraunhofer IFF and other institutions to the 17th International Conference on Reliability and Statistics in Transportation and Communication, which was held on 18-21 October 2017, in Riga, Latvia. Part of them was approved for presentation in Young Researchers' Seminar “Sustainable Transport Interchanges”.

RelStat'17 Conference was organized by the Transport and Telecommunication Institute. The purpose of the conference is to bring together academics and professionals from all over the world to discuss the following themes of the conference:

- Smart Solutions in Transportation Systems
- Networking and Telecommunications
- Reliability, Risk and Safety Applications
- Mathematics, Statistics, Modelling and its Applications
- Information Systems and Information Technologies
- Business and Economics Applications
- Mobile and Distance Education

Accepted abstracts of RelStat'17 were published in the book of abstracts, and selected papers will be published in Springer Lecture Notes in Networks and Systems http://www.springer.com/series/15179 (approximately 3 to 4 months after the Conference) - published by Springer. The journal will be submitted for indexing in Scopus, the largest abstract and citation database of peer-reviewed literature and other databases.

1.2 Project overview

ALLIANCE aims at developing advanced research and higher education institution in the field of smart interconnecting sustainable transport networks in Latvia, by linking the Transport and Telecommunication Institute – TTI with two internationally recognized research entities – University of Thessaly – UTH, Greece and Fraunhofer Institute for Factory Operation and Automation – Fraunhofer IFF, Germany. The close collaboration of TTI with UTH and Fraunhofer IFF will enable the achievement of the goals through the following activities:

- Organization of young researchers’ seminars.
- Organization of workshops.
- Organization of summer schools for trainers and young researchers.
- Development of an educational programme for graduate and post-graduate students.
- Development of training programme for trainers and practitioners.

- Provision of grants for participation as authors of peer reviewed publications in conferences.
- Facilitation of Short-Term Staff Exchanges (STSE's) with the aim of international collaboration, mainly publications.
- Establishment of a guidance strategy for preparing scientific publications.
- Creation of an educational forum as an on-line tool for distance learning and knowledge sharing.

The overall methodology of the project is built around the analysis of the needs of Latvia and the surrounding region of the Baltic sea (Lithuania, Estonia, Poland) on knowledge gain about intermodal transportation networks and the development of the tools to attain this knowledge, providing at the same time excellence and innovation capacity. The analysis to be conducted during the first stages of the project, steps on the overarching relations among policy makers, industry and education/research.

Structured around three main pillars, organizational/governance, operational/services and service quality/customer satisfaction, ALLIANCE will deliver a coherent educational/training program, addressed to enhancing the knowledge of current and future researchers and professionals offering their services in Latvia and the wider region.

The expected impacts on the overall research and innovation potential of TTI and Latvian research community will be of high importance and TTI will benefit from ALLIANCE by:

- Improving its knowledge in methodologies for preparing, writing and publishing scientific papers.
- Strengthening its research capacity.
- Establishing international research teams in specific areas of interest.
- Generating new innovative ideas for future research work through the project's activities.
- Setting up the fundamentals for the young generation of researchers.
- Being integrated into a number of existing international transportation research networks.
- Being incorporated in the European research system of transport and logistics.

In addition, the cooperation of TTI with UTH and Fraunhofer IFF will induce benefits into several domains of everyday life at regional, national and international scope. New bases will be established concerning knowledge transfer procedures, education and interdepartmental collaboration amongst research institutes. The innovative organizational framework, which will be structured for this purpose during the project, is expected to constitute a best practice application with tangible and well estimated progress results, which will be disseminated and communicated through social events to the research community and to the respective business sector as well.

Lastly, an important benefit will be the configuration of an integrated framework pertaining to the knowledge transfer techniques and the generic upgrading of the educational system with the use of networking, staff exchange, webinars and other knowledge transfer methods and techniques based on a well-structured and well-tried schedule.

2 ALLIANCE scientific contribution in RelStat’17

ALLIANCE team encourages young researchers to submit their relevant research in three thematic areas: governance and policy development, smart solutions, decision-making.

In total, twelve abstracts were prepared by young researchers (from TTI, UTH, Fraunhofer IFF and other institutions) and were reviewed by the reviewers of the Young Researchers Seminar (YRS), members of the ALLIANCE project consortium:

- Prof. Irina Yatskiv (TTI, Latvia)
- Prof. Igor Kabashkin (TTI, Latvia)
- Prof. Jury Tolujew (TTI, Latvia)
- As. Prof. Mihails Savrasovs (TTI, Latvia)
- Assist. Prof. Dmitry Pavlyuk (TTI, Latvia)
- Prof. Eftihia Nathanail (UTH, Greece)
- Dr. Giannis Adamos (UTH, Greece)
- Dr. Lambros Mitropoulos (UTH, Greece).

Twelve abstracts were accepted, and the authors received the official notification from the moderators of ALLIANCE YRS and were invited to present their research work within the framework of the 17th International Conference on Reliability and Statistics in Transportation and Communication (RelStat'17), hosted by Transport and Telecommunication Institute in Riga, the capital of the Republic of Latvia, in October 18-21, 2017.

In total, eleven abstracts were chosen for presentation in special session “Sustainable Transport Interchanges” and one was recommended for presentation in another session (Intelligent Transport Systems) of the 17th International Conference on Reliability and Statistics in Transportation and Communication. The YRS Special Session included papers presenting technical, experimental, methodological and/or applicative contributions in the scope of Sustainable Transport Interchanges.

The title, authors, abstract and keywords for each of these chosen for YRS presentations are included in Tables 1-11. The Conference’s program is given in Annex A, the data about the conference and content are provided in Annex C, and the presentations from special sessions are provided in Annex D. Additionally, a special feedback form was developed and distributed to the participants and visitors of YRS Special Session (see Annex B). The form was used to express the opinion about the presentations carried out. In the end of the sessions, feedback forms were collected and provided to the presenters.

Table 1: Presentation 1 – Analysis of Riga International Airport Flight Delays

Code:	**1**
Responsible or involved partner:	TTI
Paper title:	Analysis of Riga International Airport Flight Delays
Author(s):	Iyad Alomar, Jurijs Tolujevs, Aleksandrs Medvedevs

Reference:	Alomar, I., Tolujevs, J. & Medvedevs, A., 2017. "Analysis of Riga International Airport Flight Delays". 17th International Conference on Reliability and Statistics in Transportation and Communication, Riga Latvia, 18-21 October 2017.
Abstract: Flight delays have negative consequences on airlines, airports and passengers. On-time operation of the airports and airlines schedules are the target of all airports and airlines stockholders in order to fulfil with passengers and customer requirements as well as getting more new customers. Flight schedules are subject to inconsistency due to various reasons. Flight delays could be seasonal or due to current conditions of operations, lake of equipment, bad management, etc. One of the main parts of airport and airlines expenses and losses is that losses are coming from flight delays. Delays of the aircrafts by reasons are tightly related to the ground handling services are quite often observed. Analysing of delays and their reasons will be helpful to improve the prediction of future delays and reduces them as well as reduces of the waiting and downtime of the aircraft on the ground. During future article, we plan to perform statistical analysis of airport flight delays, and then in future link and use the results of the analysis in our research.	
Keywords:	ground handling; flight delay; on-time operation; statistical analysis

Table 2: Presentation 2 – Mechanisms for Investment in the Transport Infrastructure Development in Latvia

Code:	**2**
Responsible or involved partner:	TTI, Fraunhofer IFF
Paper title:	Mechanisms for Investment in the Transport Infrastructure Development in Latvia
Author(s):	Irina Kuzmina-Merlino, Oksana Skorobogatova, Niels Schmidtke, Fabian Behrendt
Reference:	Skorobogatova, O., Kuzmina-Merlino, I., Schmidtke, N., Behrendt, F., 2017. "Mechanisms for Investment in the Transport Infrastructure Development in Latvia". 17th International Conference on Reliability and Statistics in Transportation and Communication, Riga Latvia, 18-21 October 2017.
Abstract: Well-developed and efficient infrastructure is crucial for ensuring the effective functioning of the economy. The transport and storage sector is one of the most promising sectors in the Latvian economy, and today it contributes 9.5% of GDP (LIAA, 2017). However, despite the successes in the development of the industry, one of the most problematic factors for doing business is inadequate supply of infrastructure. In Latvia, due to the limited state funding, the country's ability to create a new infrastructure and maintain the existing is reduced significantly. A considerable lack of industry financing certainly affects the assessment of the quality of the overall infrastructure in a global context; in 2015, according to an assessment made by the World Economic Forum, Latvia is ranked 51st among 138 countries (World Economic Forum, 2016). In countries that have a high rating on the quality of the overall infrastructure, for example, Germany, appropriate investment mechanisms have been developed. They set benchmarks for decision-making and evaluation of investment efficiency. In these countries, investments in transport infrastructure allow linking the main development goals of the country with the available resources. The article focuses on studying the following issues: 1) What mechanisms of investment in transport infrastructure are used in countries	

that have a high rating of the quality of overall infrastructure? 2) What underlies the evaluation of the effectiveness of the invested funds? 3) How the investment mechanism influences the choice of the priority of the project and the evaluation of the project's effectiveness. The results of the study show which analytical tools and processes can be used to prioritize transport infrastructure needs and evaluate projects that can meet these needs. In general, the results of the study can be useful in developing mechanisms for investing in the development of transport infrastructure in Latvia as an integral part of the investment policy for the industry development	
Keywords:	transport infrastructure, investing mechanism, ranking, effectiveness

Table 3: Presentation 3 – Assessing the Design and Operation of Riga's International Coach Terminal

Code:	**3**
Responsible or involved partner:	TTI, UTH
Paper title:	Assessing the Design and Operation of Riga's International Coach Terminal
Author(s):	Maria Tsami, Evelina Budilovich, Vissarion Magginas, Giannis Adamos, Irina Yatskiv (Jackiva)
Reference:	Tsami, M., Budilovich, E., Magginas, V., 2017. Adamos, G., Yatskiv (Jackiva), I., "Assessing the Design and Operation of Riga's International Coach Terminal". 17th International Conference on Reliability and Statistics in Transportation and Communication, Riga Latvia, 18-21 October 2017.
Abstract: The present paper aims at identifying the Riga's International Coach Terminal performance, by assessing its design and operation. Towards this direction and based on an extended state of the art review of best practices, a list of selected indicators, grouped under eight clusters, were used and assessed by station users. These clusters deal with mobility provision, way-finding information, time and movement issues in the station, accessibility, comfort, station image and attractiveness, safety and security, and handling of emergency situations. The objectives of the research are to: • point out the level of users' satisfaction from the current station operation, infrastructure and services, • correlate the above attributes with the overall station assessment, users' profiles, special characteristics and needs and users' decision making in regard to travel behaviour and mode choice. For the data collection, an extended face-to-face and internet-based questionnaire survey was conducted, with station users stating their perceptions and level of satisfaction, related to the terminal infrastructure, operation and services, as classified in the aforementioned eight clusters of indicators. The survey was designed within the framework of the European Project City-HUB (1), and was adopted for this particular case. A decision tree approach was used to indicate the key performance indicators in users' assessment formulation for the case study. Research findings, define the most significant parameters that need to be modified in order to increase users' satisfaction, which will gradually also increase the overall image and attractiveness of the station and the usage of its services. In addition, this approach will provide significant input into proper design and operation of urban transport interchanges, efficient usage and guidance on methods to increase users' satisfaction.	
Keywords:	urban transport; decision tree; interchanges; city hubs; public transportation systems

Table 4: Presentation 4 – Smart Solution for 3PL Operators: State-Of-The-Art

Code:	4
Responsible or involved partner:	TTI
Paper title:	Smart Solution for 3PL Operators: State-Of-The-Art
Author(s):	Aleksandrs Avdeikins, Mihails Savrasovs
Reference:	Avdeikins, A., Savrasovs, M., 2017. “Smart Solution for 3PL Operators: State-Of-The-Art”. 17th International Conference on Reliability and Statistics in Transportation and Communication, Riga Latvia, 18-21 October 2017.
Abstract: Logistics is the most fast changing and rapid businesses in the world. It plays significant role in most of the business processes. Every company producing goods or services needs to setup supply chain management procedure to be competitive in the market and cost effective. Sometimes such task is very complicated and it is better to outsource it to professionals or 3PL (Third Party Logistics) operators. According to Logistics Focus 3PL is the activity of outsourcing activities related to Logistics and Distribution. The 3PL industry includes Logistics Solution Providers (LSPs) and the shippers whose business processes they support. Eyefortransport Ltd., who is the global business intelligence provider for supply chains and transportation, stands, that 3PL supply logistics related operations between traders by an independent organization As seen from definitions 3PL operator always plays role in the middle. Such role force 3PL operators to implement and use smart solutions and informational processes. As 3PL normally serves more than one client its technologies should be as much flexible as possible to support client own processes, such as: • Receiving and issuing of goods; - Planning inbound receipt procedures. - Outbound delivery procedures • Quality control or verification; • Storage of goods - Location management - Inventory control -Occupational health and safety - Information flow. Smart solutions allow to implement all operations in the more effective way, but the intensive development of modern technologies rise the question about applicability, security, effectiveness and scalability of the such technologies use in practice. There are many scientific articles and books referencing to this issue, but most of them are targeted only on one technology. Some examples could be found in (Uckelmann, 2012). That is why the goal of this paper is to make wide-scale analysis of the existing technologies, like IoT, AI, Drones, EDI Communication, PDA/Tablets, RFID, Barcodes/optical recognition, Big Data etc, which could be applied for 3PL and evaluate technology readiness level, as well to map technologies to the standard business processes of the 3PL companies.	
Keywords:	3PL, Smart Solution, TRL

Table 5: Presentation 5 – Big Data in Transport – Data Sources and Data Sets Used in Literature

Code:	**5**
Responsible or involved partner:	UTH
Paper title:	Big Data in Transport – Data Sources and Data Sets Used in Literature

Author(s):	Maria Karatsoli, Eftihia Nathanail
Reference:	Karatsoli, M., Nathanail, E., 2017. “Big Data in Transport – Data Sources and Data Sets Used in Literature”. 17th International Conference on Reliability and Statistics in Transportation and Communication, Riga Latvia, 18-21 October 2017.

Abstract:

The development of Information and Communications Technology (ICT) and the Internet provide Intelligent Transport Systems (ITS) with a huge amount of real-time data. These data are the so-called "Big Data" which can be collected, interpreted, managed and analyzed in a proper way in order to improve the knowledge around the transport system. The term "Big Data" refers to all those data whose scale, diversity and complexity require new analysis techniques and algorithms (Chandrasekar, 2015). The use of these technologies has greatly enhanced the efficiency and user friendliness of ITS, providing significant economic and social impacts, contributing positively to the management of sustainable mobility. In this paper, different sources of big data that have been used in ITS are presented, while their advantages and limitations are further discussed. Analytically, big data sources that have been used within the last 15 years are identified and classified based on different criteria, i.e. the accessibility of the source, the type of the data recorded. Then, a review of current applications is done and based on a statistical analysis the most used and proper data source per case, is indicated. Aim of the present study is to improve the knowledge around the usage of Big Data in transport planning and to contribute to the better support of ITS, by providing a roadmap to decision makers for big data collection methods.

Keywords:	data collection, Intelligent Transport Systems, Information and Communications Technology, big data classification, traffic information, real-time data

Table 6: Presentation 6 – Evaluating Smart Urban Freight Solutions Using Microsimulation

Code:	**6**
Responsible or involved partner:	UTH, TTI
Paper title:	Evaluating Smart Urban Freight Solutions Using Microsimulation
Author(s):	Ioannis Karakikes, Lambros Mitropoulos, Mihails Savrasovs
Reference:	Karakikes, I., Mitropoulos, L., Savrasovs, M., 2017. “Evaluating Smart Urban Freight Solutions Using Microsimulation”. 17th International Conference on Reliability and Statistics in Transportation and Communication, Riga Latvia, 18-21 October 2017.

Abstract:

Last mile distribution remains a difficult-to-solve variable in urban congestion’s equation, especially in Europe due to increased population and economic growth and limited space. Over the last decades, several European projects have contributed significantly into that direction, by developing innovative concepts (e.g., electric solutions, ITS adoption, effective policy-based strategies). A great number of measures have been deployed and have been considered as possible solutions to the last mile distribution problem of European cities, however only few of them have actually been implemented and tested over a long period of time and their impacts have been quantified. Focusing on an urban interchange -Volos Port-, different smart UFT solutions will be evaluated by using a microscopic traffic simulation tool to disclose which is the most effective in environmental and transportation terms. This study aims to compare different

smart solutions and evaluate their performance by assessing different scenarios. The impacts will be measured by replicating traffic conditions in the transport network around the port. The number of vehicles that are used for pick-ups and deliveries as well as the traffic volumes of the surrounding area will be provided for a typical day. Having calibrated and validated the model, the number of deliveries and pick-ups as well as the traffic volumes will be projected to 2020 and 2030 in order to assess solutions' effectiveness in the short as well in the long term. Results will show which of the evaluated solutions have the greatest impact towards alleviation of congestion in the city of Volos. The analysis will be completed by using a multi-criteria multistakeholder decision making tool to generate the Logistics Sustainability Index (LSI) for each measure to summarise results and provide a sustainability based rating to support local decision making.

Keywords:	city logistics, evaluation, lifecycle analysis, microsimulation, logistics sustainability index

Table 7: Presentation 7 – Development Prospects of Road Transport in Kazakhstan as Part of The Strategy "Nurly Zhol"

Code:	**7**
Responsible or involved partner:	TTI, Al-Farabi Kazakh National University
Paper title:	Development Prospects of Road Transport in Kazakhstan as Part of The Strategy "Nurly Zhol"
Author(s):	Gani Askarov, Utegali Shedenov, Jurijs Tolujevs
Reference:	Askarov, G., Shedenov, U., Tolujevs, J., 2017. "Development Prospects of Road Transport in Kazakhstan as Part of The Strategy "Nurly Zhol"". 17th International Conference on Reliability and Statistics in Transportation and Communication, Riga Latvia, 18-21 October 2017.

Abstract:

The economy of Kazakhstan located in the centre of the Eurasian continent between the capacious and dynamically developing markets of Europe, East and South-East Asia, is highly dependent on the effective use of the transport capacity of the state. Therefore, in terms of area, the republic is one of the world's 10 largest countries, occupying about 2% of the world's surface, 6.1% Asia's territory (Shedenov and Askarov, 2015). The transport system is a key component of Kazakhstan's infrastructure and it has a major impact on the level of development of the country's economy. The transport complex accounts for almost 20% of the productive assets value, over 35% of energy consumption, and about 10% of the working population. The share of transport represents approximately 8% of GDP (Bekmagambetov and Smirnova, 2012). Transport complex of Kazakhstan contains all the main types of transport used in world practice. Each of them has a role in the national economy. Road transport is consistently leads in the total traffic and provides more than 80% of it, more than 30% of turnover and 95% of passenger turnover, serving virtually all sectors of the economy (Ministry of National economy, 2017). In his Address to the people of Kazakhstan entitled "Nurly Zhol - Way to the Future" (The Address of President, 2014), President Nazarbayev outlined the key points of the new deal, the new economic policy of Kazakhstan, in particular: "Development of transport infrastructure". The development and implementation of an integral strategy aimed at ensuring the sustainable competitiveness of the economy is the main direction of state policy for successful integration of Kazakhstan into the world economy. In the present article, the features of road transport's development in the Republic of Kazakhstan are considered, the transportation patterns in recent years are analyzed and strategies for the development of transit traffic are formulated. In addition, in this work, problems in the given branch are considered and recommendations for the decision of these problems are given.

Keywords:	transport and logistics infrastructure, hubs, transit traffic

Table 8: Presentation 8 – Modelling and Simulation of the Riga International Airport to Reduce Turnaround Times of Crucial Clearance Processes

Code:	**8**
Responsible or involved partner:	TTI, Fraunhofer IFF
Paper title:	Modelling and Simulation of the Riga International Airport to Reduce Turnaround Times of Crucial Clearance Processes
Author(s):	David Weigert, Alina Rettmann, Iyad Alomar, Juri Tolujew
Reference:	Weigert, D., Rettmann, A., Alomar, I., Tolujew, J., 2017. "Modelling and Simulation of the Riga International Airport to Reduce Turnaround Times of Crucial Clearance Processes". 17th International Conference on Reliability and Statistics in Transportation and Communication, Riga Latvia, 18-21 October 2017.

Abstract:

Due to the rise of low cost carriers within the airline industry and rising numbers of passengers, airlines and airports alike try to optimise their processes to maximise their revenue. Worldwide the number of air passengers will nearly double between 2016 and 2035 (Statista GmbH, 2017). This development can also be witnessed in the European union, as the amount of passengers in air transport industry grew in the EU28 by 4,72 percent between 2014 and 2015 (eurostat statistics explained, 2016). As a matter of fact an airplane only creates sales revenue as long as it transports passengers and therefore airlines try to minimize their airplane's ground time and optimise all processes on the ground. Generally, every airplane has to go through several processes. These include the parking, the way to and on the taxiway, take-off and departure, the climb at the beginning of the flight, the cruise, the descent, the approach towards the destination airport, landing at the airport and the drive to the gate or stand. As about 70 % of all delay happens due operations happening on the ground (European Commission, 2011), it seem to be a promising approach to optimise the time needed on the ground, in particular to optimise the routing of ground vehicles. Operation figures to measure an improvement are the non-operation period of an airplane, the (estimated) time of travel for ground vehicles and the distance the ground vehicles need to drive. Control factors are the parking position of the airplane and the routing algorithm of the ground vehicles. The main course of action to tackle this problem is a simulation study. As a preparation for the simulation study, to create actual data and to determine the primary processes happening during the ground time of an airplane, a rough calculation and a conceptual model were developed. The Riga International Airport (RIX) was taken as a basic model. The ground handling process, all operations happening while the airplane is parked and therefore non-operated, can be divided in terminal processes that happen within the terminal, for example baggage claim, check and handling, or airside processes which mostly happen on the airside of the airport and include ramp and on-ramp aircraft servicing (Ashford, et al.,1997- 2015). As aircraft handling practices, equipment and resources differ among airlines (Casanova, Jesse, 2013; AIRBUS S.A.S Customer Service Technical Data Support and Services, 2005), it was decided to focus on general processes happening at an airport, to enable common conclusions. The following processes were considered: The airplane moves to its assigned stand, deplaning of all passengers and unloading all baggage from the airplane, cleaning and catering of the airplanes galley, fueling of the airplane, the enplaning of all passengers and loading of baggage, the airplane leaves its stand and moves to the runway for take-off. Difficulties during data preparation, the development process of the conceptual model, formalisation of the conceptual model and the results, which have been achieved until now as well as a forecast to future tasks, are discussed in this paper. With the Riga International

Airport as a basic model, a simulation study of chosen ground operations, including aircraft handling and ground vehicle movement in order to minimise the lead-time of aircraft handling, can be determined as future task. In this context, the development of scenarios and experiments as well as a change in ground vehicle movement traffic routing will be considered.

Keywords:	ground vehicle movement, routing, aircraft processes

Table 9: Presentation 9 – Wide-Scale Transport Network Microscopic Simulation Using Dynamic Assignment Approach

Code:	**9**
Responsible or involved partner:	TTI
Abstract title:	Wide-Scale Transport Network Microscopic Simulation Using Dynamic Assignment Approach
Author(s):	Mihails Savrasovs, Irina Pticina, Valery Zemlyanikin
Reference:	Savrasovs, M., Pticina, I., Zemlyanikin, V., 2017. “Wide-Scale Transport Network Microscopic Simulation Using Dynamic Assignment Approach”. 17th International Conference on Reliability and Statistics in Transportation and Communication, Riga Latvia, 18-21 October 2017.

Abstract:

Traffic microscopic simulation is a powerful decision supporting tool, which could be applied for wide range of tasks. In a past microscopic traffic simulation was used to test local changes in transport infrastructure, but the growth of computers performance allows now to simulate wide-scale fragments of the traffic network. But this leads to the problem of how to simulate such a complex network. One of the possible solutions is to apply dynamic assignment (DA) approach in simulation. The DA is the approach, which is used to define the paths for the traffic flows throw the network. But use of DA puts additional tasks in phase of model development and application: 1) DA require use of origin-destination matrix (OD), it means that such OD matrix should be estimated; 2) the calibration process of the DA is complex, timeconsuming and intuitive process, but to get a valid model for further use, this process should be completed obligatory. The goal of the current paper is to presents the case-study from city of Riga (capital of Latvia), which demonstrates the application of dynamic routing approach in the complex network simulation with use of DA. The simulation was completed in PTV VISSIM simulation software. VISSIM dynamic assignment module has a number of parameters and options, which could be used to control the behaviour of the model and do the calibration to get the valid model. There are a number of recommendations in the reports and guidelines (FHWA, 2012), (Transport for London, 2010) and software manuals (PTV Planung Transport Verkehr AG, 2012), how to set up parameters for dynamic assignment. But there are no one document which unites all recommendations of DA application in VISSIM, so the additional goal of the paper is to aggregate all the information regarding recommendations of VISSIM dynamic assignment module configuration

Keywords:	simulation, traffic, dynamic assignment, wide-scale network

Table 10: Presentation 10 – Experimental Study on Distributed Road Tracking System for Road Traffic Registration

Code:	**10**
Responsible or involved partner:	TTI, Keio University
Abstract title:	Experimental Study on Distributed Road Tracking System for Road Traffic Registration
Author(s):	Alexander Dudko, Irina Yatskiv, Yasushi Kiyoki
Reference:	Dudko, A., Yatskiv, I., Kiyoki, Y., 2017. "Experimental Study on Distributed Road Tracking System for Road Traffic Registration". 17th International Conference on Reliability and Statistics in Transportation and Communication, Riga Latvia, 18-21 October 2017.

Abstract:

Annually, hundreds of thousands citizens are dying because of road traffic crashes. Only in 2015 year there were 1.25 million road traffic deaths globally caused by car accidents. Moreover, road traffic deaths among pedestrians, cyclists and motorcyclists are intolerably high. In the era of technology the number of cars in the world is constantly growing, therefore safety on roads is becoming very important nowadays. Although road traffic injuries have been a leading cause of mortality for many years, most traffic crashes are both predictable and preventable. There is considerable evidence on interventions that are effective at making roads safer: countries that have successfully implemented these interventions have seen corresponding reductions in road traffic deaths (World Health Organization, 2015). According to the global status report on road safety 2015, in the last three years, 17 countries have aligned at least one of their laws with best practice on speed, seat-belts, drink– driving, motorcycle helmets and child restraints. While there has been progress towards improving road safety legislation and in making vehicles safer, the report shows that the pace of change is too slow. Urgent action is needed to achieve the ambitious target for road safety. One of the most important factors for road safety is cars movement speeds. As average traffic speed increases, so too does the likelihood of a crash. If a crash does happen, the risk of death and serious injury is greater at higher speeds, especially for pedestrians, cyclists and motorcyclists. For the purpose of speed regulation and punishment of violating drivers, roads police department is installing speed radars. However, modern car speed radars do not solve the problem of speeding, because drivers slow down directly before the known place where the radar is located, and increase speed again after passing the radar. Such fact makes the efficiency of the radar very local, and it becomes very expensive to cover the whole area with this kind of radars to regulate the cars speeds on roads. This paper describes a smart city system of road traffic tracking to support next generation of urban transport based on techniques of Image Processing, 3D Vision, Big Data Analysis, and other novel ICT technologies. The paper describes the construction of the system, its reference architecture, and contribution to the environmental and socially important impacts. System aims to advance the existing smart city transport by means of raising urban innovations to maximize road laws enforcement and minimizing the negative effects like traffic accidents.

Keywords:	traffic accidents, road safety, smart city

Table 11: Presentation 11 – Determination of Parameters for Forming Right Allocation of Items in Picking Area

Code:	**11**
Responsible or involved partner:	TTI
Abstract title:	Determination of Parameters for Forming Right Allocation of Items in Picking Area
Author(s):	Raitis Apsalons, Genady Gromov
Reference:	Apsalons, R., Gromov, G., 2017. "Determination of Parameters for Forming Right Allocation of Items in Picking Area". 17th International Conference on Reliability and Statistics in Transportation and Communication, Riga Latvia, 18-21 October 2017.

Abstract:

Nowadays globalization is connected not only by use of different modes of transport or intermodal and multimodal transport, but also by development different methods of logistics in warehousing area. Right planning, organizing and controlling of picking process becomes vitally important. The key indicator for choose of any picking technology in the warehouse appears velocity of order lines picked per paid man hour. If number of order lines picked per paid man hour is relatively small, usually primitive picking technologies are used. Such picking technologies support physical picking system: walk and pick (Tomkins, 2003). Picking technologies here are: the paper picking, RFID picking or more developed picking technologies such as: visual picking, picking by voice (Harper, 2017). In this paper it is discussed picking are (PA) which is located into storing area (SA). This means that one row rack storing system available in the definite warehouse. Picking process will be realized by picking handling units (HU) and customer units (CU). The ground level and first level of pallet racks are used as PA. The one picking location of each item consists of 2 pallets: 1 pallet on ground level and second one on the first level of rack. The replenishment is appropriated for moving the items from SA to PA to avoid stock – outs in picking time interval. Therefore if definite item in picking location achieve critical level, replenishment starts by the signal in warehouse management system (WMS). This approach is called as Red Card principle (RCP) (Apsalons, 2012). The main purpose of paper is to determine one or more criteria for forming right allocation sequence of items into picking addresses corresponding by picking route. The definition of the scientific problem is to approve that those criteria for forming right allocation sequence of items into picking addresses can diminish total picking travel distance. The object of the research concerns the picking process. The subject of the research is allocation sequence of items into picking addresses. At first for each item (SKU – stock keeping unit) at least one picking address has planned in PA (Rushton and Walker, 2007). The replenishment process can be realized by use of approaches of the layout of items in PA: either by the single picking location for each single item, when replenishment is realised in picking process or by various picking locations for each single item, replenishment is realised just only before picking process or after it. At the second there are several routing strategies, but not all of them are suitable for any situation (ERIM, 2017). The third, there are several picking methods (Dukic and Oluic, 2005). The fourth, authors have proposed criteria for forming right allocation sequence of SKU into picking addresses corresponding by picking route (Apsalons and Gromov, 2015). The criterion 1: the number of orders for each SKU. The criterion 2: the average volume of each SKU per picked order. The

criterion 3: the total revenue of each SKU per quarter (forming of quarters depends on seasonal aspect). The criterion 4: the group of brands of SKU. The criterion 5: the key accounts of consumers. The criterion 6: the key accounts of suppliers. The criterion 7: the average turnover of each SKU in a day. The criterion 8: the size of each SKU. The criterion 9: the gross weight of HU or CU. We would like to stress that this list of criteria does not mean that in warehouse for planning right allocation sequence of items into picking addresses corresponding by picking route only one single criterion could be used. The logical algorithm of forming right allocation sequence of items contains various criteria. It has been developed by authors. However a choice of appropriate criteria and forming logical algorithm is unequivocally. It depends on picking systems, storing systems, from the speed of the turnover of each SKU, etc. There are some serious questions which will be as guidelines for building right allocation sequence of items into picking addresses corresponding by picking route: what is level of similarity of SKU; are items intended or ordered by few clients or delivery points; what kind of warehouse systems and racks will be planned in PA; what is the impact of size, weight and volume of each SKU; what is capacity of picking cars used in picking process; what is the impact of turnover of each SKU?

Keywords:	picking process, replenishment of items, picking route, locations, right allocation of items, criteria of allocation

3 Analysis

Eleven presentations were made by ALLIANCE partners during the special session "Sustainable Transport Interchanges", six out of which were made by TTI representatives from Latvia and the rest five by the UTH, Fraunhofer IFF and other representatives (see Figure 1).

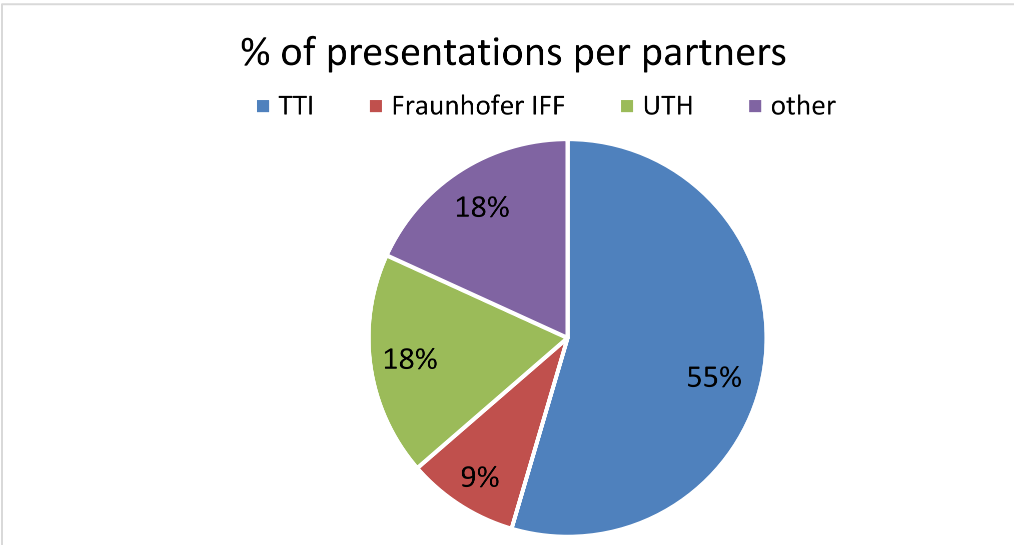

Figure 1: % of presentations per partners

In total, there are 28 authors and co-authors of the presentations. Figure 2 shows the distribution of authors and co-authors by ALLIANCE partners and other universities and research institutes.

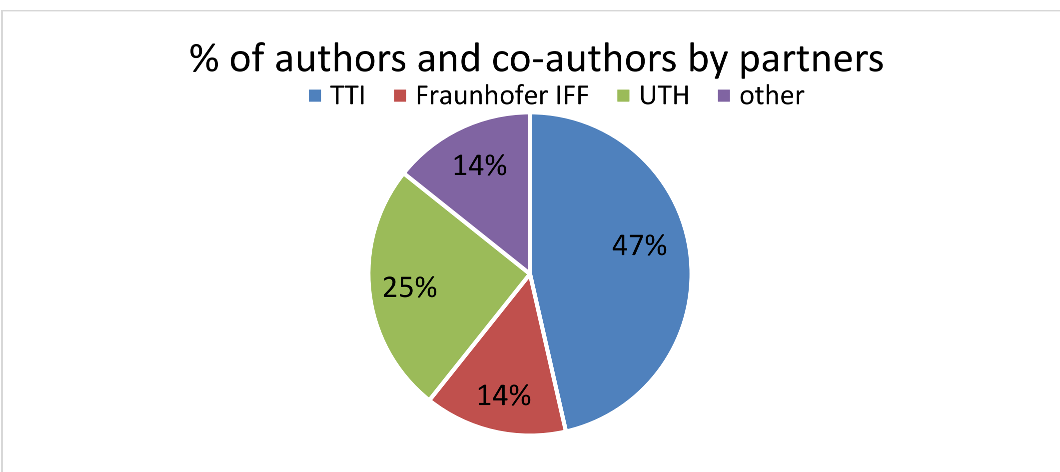

Figure 2: % of authors and co-authors by partners

In addition, 36% of the authors or co-authors of the presentations were female, and the rest 64% were male, which shows an acceptable gender balance (Figure 3).

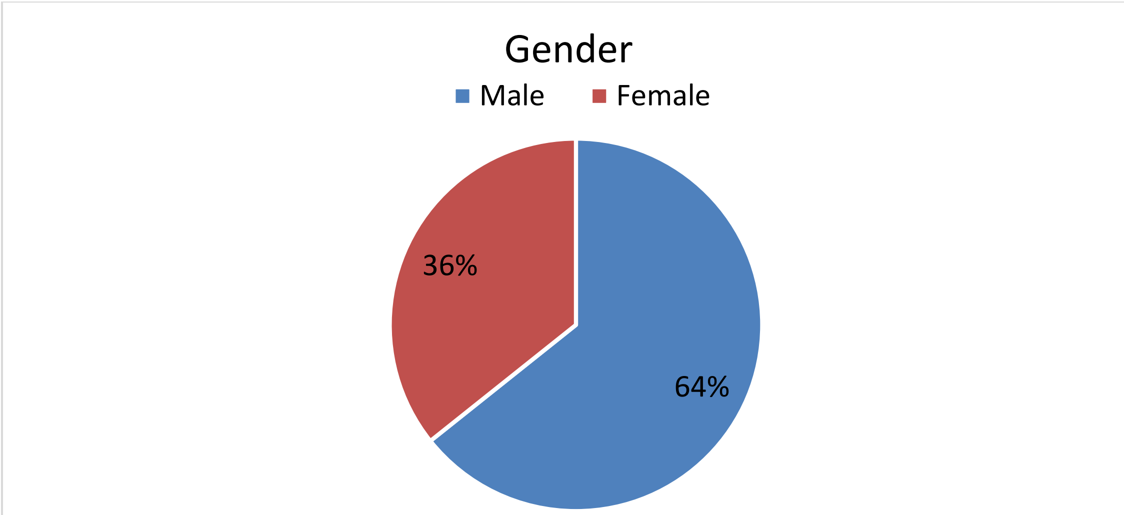

Figure 3: Gender distribution

Lastly, 57% of the authors or co-authors were young researchers and the rest 43% were senior researchers, addressing the scope of ALLIANCE for the active involvement of students and young researchers in its activities (Figure 4).

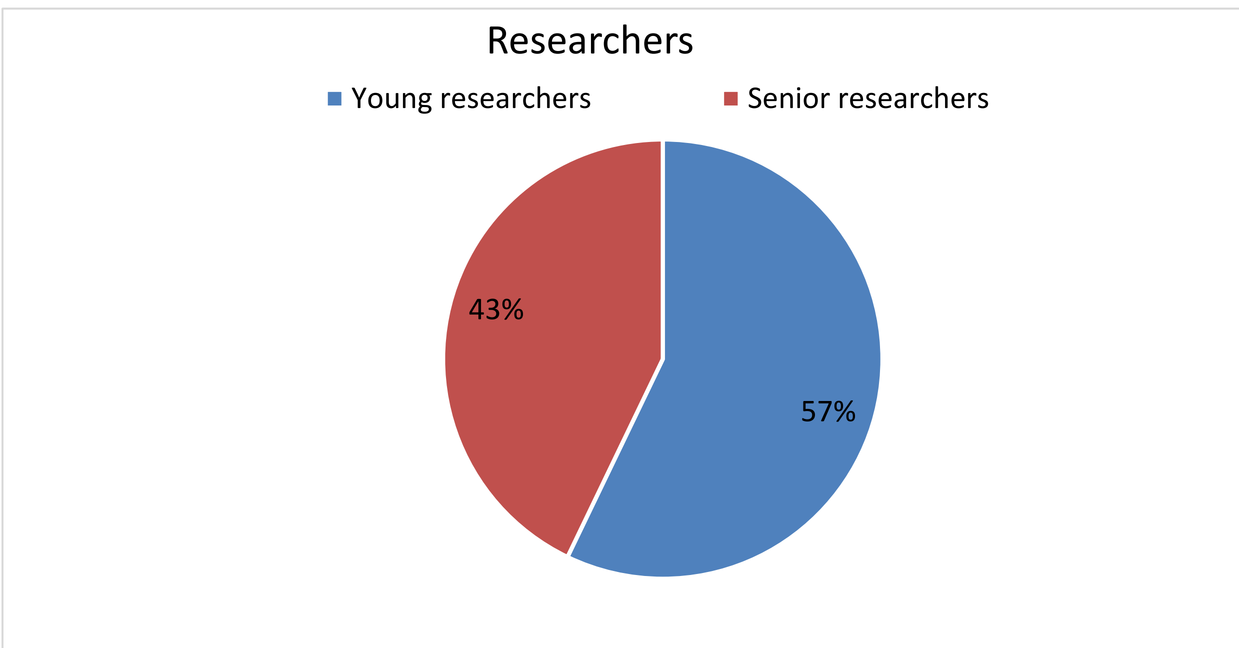

Figure 4: Percentage of young & senior researchers

4 Synopsis

This deliverable is the compendium of the ALLIANCE contribution to the 17th International Conference on Reliability and Statistics in Transportation and Communication (RelStat'17), which was held on 18-21 October 2017 in Riga, Latvia.

Twelve abstracts were accepted, and the authors received an official notification from the moderators of ALLIANCE YRS and were invited to present their research work.

Eleven abstracts were chosen for presentation in the special session "Sustainable Transport Interchanges" and one abstract was recommended for presentation in another session (Intelligent Transport Systems) of the 17th International Conference on Reliability and Statistics in Transportation and Communication. It should be noted, that three of eleven abstracts are not directly related to the scope of the project, but they are related to transportation and logistics in general, they were also included in a special session of ALLIANCE as presentations, while in the book of abstracts they are listed under different sections (see Annex C).

Table 12: Overview of the activity

No	Type of activity	Main Leader	Title	Date/period	Place	Type of audience	Size of audience	Countries addressed
1	17th International Conference	TTI	Reliability and Statistics in Transportation and Communication	18-21 October 2017	Riga, Latvia	Research & academics communities, Local & regional authorities, Transport & terminal operators, Transport policy makers & influencers, Enterprises /Businesses, General public	145 participants	11 abstracts in Special Session and 1 - in other

Table 13: Overview of contribution to YRS

No.	Title	Authors	Title of the periodical or the series	Number, date or frequency	Publisher	Place of publication	Year of publication	Contribution	Permanent identifiers (e.g.. link, if available)	Is/Will open access provided to this publication?
1	Analysis of Riga International Airport Flight Delays	Iyad Alomar, Jurijs Tolujevs, Aleksandrs Medvedevs	Compendium of abstracts presented at the 17th International Conference on Reliability and Statistics in Transportation and Communication	October 2017	ALLIANCE Project	Riga, Latvia	2017	Abstract, paper, presentation	www.alliance-project.eu/deliverables/	Yes
2	Mechanisms for Investment in the Transport Infrastructure Development in Latvia	Irina Kuzmina-Merlino, Oksana Skorobogatova, Niels Schmidtke, Fabian Behrendt	Compendium of abstracts presented at the 17th International Conference on Reliability and Statistics in Transportation and Communication	October 2017	ALLIANCE Project	Riga, Latvia	2017	Abstract, paper, presentation	www.alliance-project.eu/deliverables/	Yes
3	Assessing the Design and Operation of Riga's International Coach Terminal	Maria Tsami, Evelina Budilovich, Vissarion Magginas, Giannis Adamos, Irina Yatskiv (Jackiva)	Compendium of abstracts presented at the 17th International Conference on Reliability and Statistics in Transportation and Communication	October 2017	ALLIANCE Project	Riga, Latvia	2017	Abstract, paper, presentation	www.alliance-project.eu/deliverables/	Yes
4	Smart Solution for 3PL Operators: State-Of-The-Art	Aleksandrs Avdeikins, Mihails Savrasovs	Compendium of abstracts presented at the 17th International Conference on Reliability and Statistics in Transportation and Communication	October 2017	ALLIANCE Project	Riga, Latvia	2017	Abstract, paper, presentation	www.alliance-project.eu/deliverables/	Yes
5	Big Data in Transport – Data Sources and	Maria Karatsoli, Eftihia Nathanail	Compendium of abstracts presented at the 17th International Conference on Reliability and Statistics	October 2017	ALLIANCE Project	Riga, Latvia	2017	Abstract, paper, presentation	www.alliance-project.eu/deliverables/	Yes

No.	Title	Authors	Title of the periodical or the series	Number, date or frequency	Publisher	Place of publication	Year of publication	Contribution	Permanent identifiers (e.g.. link, if available)	Is/Will open access provided to this publication?
	Data Sets Used in Literature		in Transportation and Communication							
6	Evaluating Smart Urban Freight Solutions Using Microsimulation	Ioannis Karakikes, Lambros Mitropoulos, Mihails Savrasovs	Compendium of abstracts presented at the 17th International Conference on Reliability and Statistics in Transportation and Communication	October 2017	ALLIANCE Project	Riga, Latvia	2017	Abstract, paper, presentation	www.alliance-project.eu/deliverables/	Yes
7	Development Prospects of Road Transport in Kazakhstan as Part of The Strategy "Nurly Zhol"	Gani Askarov, Utegali Shedenov, Jurijs Tolujevs	Compendium of abstracts presented at the 17th International Conference on Reliability and Statistics in Transportation and Communication	October 2017	ALLIANCE Project	Riga, Latvia	2017	Abstract, presentation	www.alliance-project.eu/deliverables/	Yes
8	Modelling and Simulation of the Riga International Airport to Reduce Turnaround Times of Crucial Clearance Processes	David Weigert, Alina Rettmann, Iyad Alomar, Juri Tolujew	Compendium of abstracts presented at the 17th International Conference on Reliability and Statistics in Transportation and Communication	October 2017	ALLIANCE Project	Riga, Latvia	2017	Abstract, paper, presentation	www.alliance-project.eu/deliverables/	Yes
9	Wide-Scale Transport Network Microscopic Simulation Using Dynamic Assignment Approach	Mihails Savrasovs, Irina Pticina, Valery Zemlynikin	Compendium of abstracts presented at the 17th International Conference on Reliability and Statistics in Transportation and Communication	October 2017	ALLIANCE Project	Riga, Latvia	2017	Abstract, paper, presentation	www.alliance-project.eu/deliverables/	Yes
10	Experimental Study on Distributed Road Tracking System for Road	Alexander Dudko, Irina Yatskiv, Yasushi Kiyoki	Compendium of abstracts presented at the 17th International Conference on Reliability and Statistics in Transportation and Communication	October 2017	ALLIANCE Project	Riga, Latvia	2017	Abstract, paper, presentation	www.alliance-project.eu/deliverables/	Yes

No.	Title	Authors	Title of the periodical or the series	Number, date or frequency	Publisher	Place of publication	Year of publication	Contribution	Permanent identifiers (e.g.. link, if available)	Is/Will open access provided to this publication?
	Traffic Registration									
11	Determination of Parameters for Forming Right Allocation of Items in Picking Area	Raitis Apsalons, Genady Gromov	Compendium of abstracts presented at the 17th International Conference on Reliability and Statistics in Transportation and Communication	October 2017	ALLIANCE Project	Riga, Latvia	2017	Abstract, paper, presentation	www.alliance-project.eu/deliverables/	Yes

ANNEX A: Agenda of YRS "Sustainable Transport Interchanges"

<table>
<tr><td colspan="3">Enhancing excellence and innovation capacity in sustainable transport interchanges
ALLIANCE
(Grant agreement no.: 692426)

Young Researcher Seminar "Sustainable Transport Interchanges"
Agenda

Location: Transport and Telecommunication Institute, Lomonosov street 1, Aud. 130
19-20 October 2017, Riga, Latvia</td></tr>
<tr><th colspan="3">19 October 2017</th></tr>
<tr><th>Time</th><th colspan="2">Topic</th></tr>
<tr><td>09:15 – 10:00</td><td colspan="2">Registration and Welcome Coffee (Aud. 130)</td></tr>
<tr><td>10:00 – 10:15</td><td colspan="2">Opening Session. (Hall#1 – Aud. 130). Moderator: TTI Vice-Rector, Prof. Irina Yatskiv (Latvia)
Welcome speech from TTI Acting Rector, Juris Kanels (Latvia)</td></tr>
<tr><td>10:15 – 12:30</td><td colspan="2">Plenary Session (Hall#1 – Aud. 130). Moderator: TTI Vice-Rector, Prof. Irina Yatskiv (Latvia)
• Prof. Nicos Komninos (Greece)
Smart Specialisation Strategies: An Online Platform for Strategy Design and Ass essment
• Prof. Eftihia Nathanail (Greece)
A Multistakeholder Multicriteria Decision Support Platform for Assessing Urban Freight Transport Measures
• Prof. Guido Gentile (Italy)
Simulation of Congestion in Public Transport Networks</td></tr>
<tr><td>12:30 – 13:30</td><td colspan="2">Lunch</td></tr>
<tr><td>13:30 – 15:30</td><td colspan="2">Parallel Sessions of RelStat’17</td></tr>
<tr><td>15:30 – 16:00</td><td colspan="2">Coffee Break</td></tr>
<tr><td>16:00 – 18:00</td><td>Parallel Sessions of RelStat’17</td><td>Train the trainer seminar in the frame of ALLIANCE project</td></tr>
<tr><th colspan="3">20 October 2017</th></tr>
<tr><th>Time</th><th colspan="2">Topic</th></tr>
<tr><td colspan="3">Special session Sustainable Transport Interchanges
Moderators: Prof. Irina Yatskiv (TTI, Latvia)
Prof. Eftihia G. Nathanail (UTH, Greece)</td></tr>
<tr><td>10:00 – 10:25</td><td colspan="2">Assessing the Design and Operation of Riga’s International Coach Terminal
Maria Tsami, Evelina Budilovich, Vissarion Magginas, Giannis Adamos, Irina Yatskiv (Greece, Latvia)</td></tr>
<tr><td>10:25 – 10:50</td><td colspan="2">Mechanisms for Investment in the Transport Infrastructure Development in Latvia
Irina Kuzmina-Merlino, Fabian Behrendt, Oksana Skorobogatova, Niels Schmidtke (Latvia, Germany)</td></tr>
</table>

10:50 – 11:15	Big Data in Transport - Data Sources and Data Sets Used in Literature **Maria Karatsoli, Eftihia Nathanail (Greece)**
11:15 – 11:40	Evaluating Smart Urban Freight Solutions Using Microsimulation **Ioannis Karakikes, Lambros Mitropoulos, Mihails Savrasovs (Greece, Latvia)**
11:40 – 12:05	Wide-Scale Transport Network Microscopic Simulation Using Dynamic Assignment Approach **Mihails Savrasovs, Irina Pticina, Valery Zemlyanikin (Latvia)**
12:05 – 12:30	Experimental study on distributed road tracking system for road traffic registration **Alexander Dudko, Irina Yatskiv, Yasushi Kiyoki (Japan, Latvia)**
12:30 – 13:30	Lunch
Time	**Topic**
Special session **Sustainable Transport Interchanges** Moderators: *Prof. Irina Yatskiv (TTI, Latvia)* *Prof. Eftihia G. Nathanail (UTH, Greece)*	
13:30 – 13:55	*Analysis of Riga International Airport Flight Delays* ***Iyad Alomar, Jurijs Tolujevs, Aleksander Medvedevs (Latvia)***
13:55 – 14:20	Modelling and Simulation of the Riga International Airport to Reduce Turnaround Times of Curcial Clearance Processes **David Weigert, Alina Rettmann, Iyad Alomar, Juri Tolujew (Germany, Latvia)**
14:20 – 14:45	Determination of Parameters for Forming Right Allocation of Items in Picking Area **Raitis Apsalons, Genady Gromov (Latvia)**
14:45 – 15:10	Smart Solution for 3PL Operators: State-of-the-Art **Aleksandrs Avdeikins, Mihails Savrasovs (Latvia)**
15:10 – 15:35	Development Prospects of Road Transport in Kazakhstan as Part of the Strategy “NURLY ZHOL” **Gani Askarov, Utegali Shedenov, Jurijs Tolujevs (Kazakhstan, Latvia)**
15:35 – 16:00	Coffee Break
16:00 – 17:30	Parallel Sessions of RelStat’17
17:30 – 18:00	Closing Session (Hall#1 – Aud.130)

ANNEX B: ALLIANCE Young Researchers Seminar Feedback Form

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 692426.

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ALLIANCE Young Researchers Seminar
Feedback form

Presenter:

Title:

Key messages I received:

____
____
____
____

What I liked:

____
____
____
____

What I disliked:

____
____
____
____

My idea for improvement:

____
____
____
____

Please return the feedback form after the session
Thank you for your feedback!

ANNEX C: RelStat'17 Abstracts proceeding

The 17th International Multi-Conference

RELIABILITY and STATISTICS in TRANSPORTATION and COMMUNICATION (RelStat'17)

18–21 October 2017. Riga, Latvia

Organised by

Transport and Telecommunication Institute (Latvia)
in co-operation with
Latvian Academy of Science (Latvia)

ABSTRACTS

Edited by

Igor V. Kabashkin

Irina V. Yatskiv

RIGA - 2017

Abstracts of the 17th International Multi-Conference *RELIABILITY and STATISTICS in TRANSPORTATION and COMMUNICATION* (RelStat'17), 18–21 October 2017, Riga, Latvia.

Transport and Telecommunication Institute
Lomonosova iela 1, LV-1019, Riga, Latvia
http://RelStat.tsi.lv

ISBN 978-9984-818-86-3

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- As. Prof. **Mihails Savrasovs**, Transport and Telecommunication Institute, Latvia
- Dr. **Ilze Sproge**, Transport and Telecommunication Institute, Latvia
- As. Prof. **Julia Stukalina**, Transport and Telecommunication Institute, Latvia
- Prof. **Juri Toluyew**, Transport and Telecommunication Institute, Latvia
- Prof. **Tatjana Volkova**, BA School of Business and Finance, Latvia
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- Asist. Prof. **Dmitry Pavlyuk**
- Ms. **Viktorija Gruzite** – Organization Manager
- Ms. **Irina Laletina** – Programme Manager

Contents

Session 3. Reliability, Safety and Risk Management

Session 4. Statistics and Modelling in Transport Applications

Session 5. Multi Criteria Decision Making in Transportation

Session 6. Smart Solutions for Supply Chain Management

ANNEX D: Presentations of special session "Sustainable Transport Interchanges"

Assessing the Design and Operation of Riga’s International Coach Terminal

M.Sc. Maria Tsami, University of Thessaly, Greece

M.Sc. Evelina Budilovich (Budiloviča), TTI, Latvia

B.Sc. Vissarion Magginas, University of Thessaly, Greece

Dr. Giannis Adamos, University of Thessaly, Greece

Prof. Irina Yatskiv (Jackiva), TTI, Latvia

This project has received funding from the *European Union's Horizon 2020 research and innovation programme* under grant agreement No 692426

17th International Conference “Reliability & Statistics in Transportation & Communication” (RelStat’17)
18-21 October 2017, Riga, Latvia

Outline

- Introduction
- State of the art
- Methodology
- Analysis and Results
- Conclusions and next steps

Introduction

One of the main goals of a Sustainable Urban Mobility Plan - is the reduction of private car use and its substitution by public transport means.

In order for this to be possible, it is necessary to provide passengers the opportunity to have a seamless journey while using a multitude of transport means [European Commission: Together Towards Competitive and Resource-Efficient Urban Mobility /COM/2013/913 final/, Brussels (2013)].

Transport interchanges

-The pyramid of urban interchanges elements-

Source: Adamos et al., 2015

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Research on the design/assessment of transport interchanges

- Terzis, G., Last, A.: GUIDE- Urban Interchanges - A Good Practice Guide, Final Report (2000)
- MIMIC: Mobility Intermodality and Interchanges. (1999)
- PIRATE: Promoting Interchange Rationale, Accessibility and Transfer Efficiency. Sheffield (2001)
- KITE: A Knowledge Base for Intermodal Passenger Transport in Europe. Vienna (2009)
- Monzon A., di Ciommo F. (2016). City-HUBs Sustainable and efficient urban transport interchanges. Retrieved from http://www.cityhub-project.eu/

CITY-HUBs
Sustainable and Efficient Urban Transport Interchanges

5

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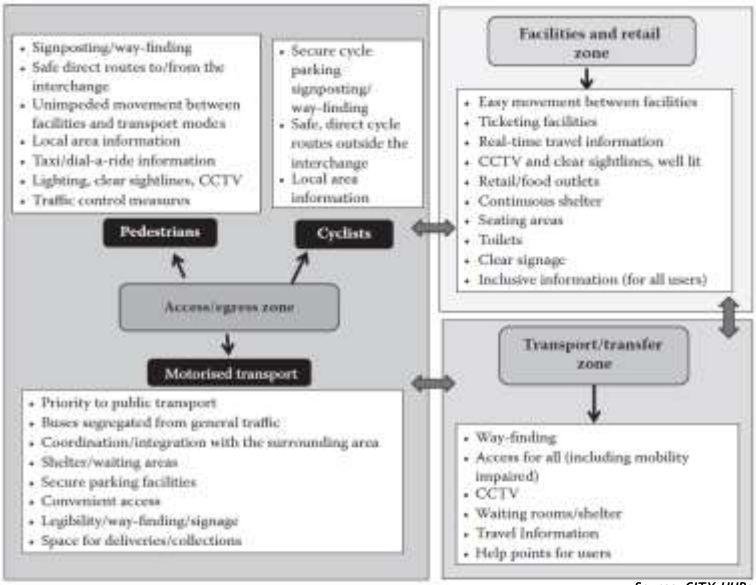
Research aim

the assessment of the design and operation indicators of the Riga's International Coach Terminal (RICT): travel information, way-finding information, time and movement issues, access to and from the station, comfort, station attractiveness, safety and security, and emergency situation

6

State-of-the-art Review

Interchange zones



Source: CITY-HUBs, 2015

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Safety and security

- the areas at the interchange's surroundings where a possible accident involving passengers and vehicles could happen
- the possibility of an accident happening inside the station. This goal can be achieved by implementing traffic control measures where necessary, while forcing a distance between passengers and vehicles could also be beneficial
- the well-lit open spaces and the avoidance of isolated areas should work positively on the passengers' perception of it
- the presence of specialized staff offering this particular service
- the emergency exits, lights and fire alarms, evacuation plan

CITY-HUBs
Sustainable and Efficient Urban Transport Interchanges

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Comfort

- the number of available seats an interchange
- the cleanliness, the temperature, the noise
- the waiting time utilization opportunities (shopping or eating) during an intermodal trip
- the amenities help create comfortable conditions during an individual's travel
- the number of automated teller machines (ATMs), Wi-Fi access and information screens

Attractive interchange design is closely related to comfort and can contribute towards creating a positive mood to passengers by providing added aesthetic value to the facilities and by creating a pleasant ambiance

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Sustainable and Efficient Urban Transport Interchanges

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Accessibility

Litman, 2015

Accessibility (or just access) refers to people’s ability to reach desired goods, services, activities and destinations (together called opportunities)

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Time

The total time reducing for a complete trip with the use of intermodal public transport

- the more time a passenger needs to reach his/her destination, the more reluctant he/she is to switch from his/her private vehicle to public transport means
- the better coordination between the different transport modes combined with reduced distances that a passenger needs to walk to facilitate the transfer between modes or reach his desired facility
- overcrowding can cause discomfort to the users of the facilities, while also hindering their movements inside the interchange and can result in reduced movement speed and even missed connections
- the transfer between different levels, the number of which should be kept to a minimum

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Ticketing and Information

- integrated ticketing has the potential to raise the use of public transport by making an intermodal movement easier and faster
- on a multimodal trip, the availability of accurate and in time information is imperative in order to have a seamless journey
- information can help travelers use their time more efficiently, as well as give them a general sense of the interchange's facilities, which is especially helpful to people with disabilities, since it can influence their choice of transport modes

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Access to and from the station

- the access/egress zones should be composed of multiple routes which provide safe passage for pedestrians and cyclists, as well as facilities for disabled passengers and those who choose to access the interchange by use of motorized vehicles
- way-finding information is very important in the design of a transport interchange (navigation aids, signing)

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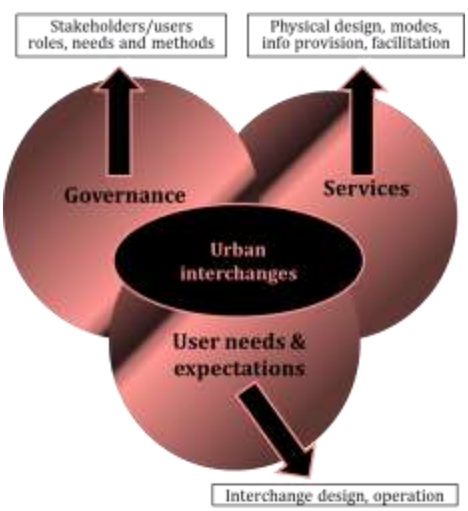
Methodology

Elements of analysis



Source: Adamos et al., 2015

State-of-the-art

Survey set-up
Data collection

Decision tree

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Survey Set-up and Data Collection

Preliminary planning
- City-HUB
- Ilford railway station, UK

Survey method
- Face-to-face
- Internet base

Sample design
- Translation into 2 languages (from English into Latvian and Russian)
- Face-to-face sample written in MS Word
- The electronic sample written in the docs.google.com template

Pilot survey
- 33 questions
- 1 language
- 1 week
- 43 answers

Main survey
- 27 questions
- 3 languages
- 1 month
- 252 answers

Your trip

1. Origin of your trip (address, district)
2. Destination of your trip (address, district)
3. When you were invited to participate in this questionnaire, were you?
4. What was the main purpose of your journey today?
5. Did you travel…? (With whom you travel)
6. Do you have any kind of disability?
7. What was the overall duration of your trip (from origin to destination/ from door to door) (min.)?
8. Total number of transfers (changes in transport mode) in your trip to (from) RICT.
9. How did you travel to (from) RICT (please state your previous transport mode)?
10. How long was your trip to (from) RICT by public transport in Riga?
11. Public transport ticket used for your trip.
12. How much time did you spend within RICT station?
13. How did this time break down (approximately)? (in min).
14. How often do you use this interchange?

Travellers' satisfaction survey RICT (Riga international coach terminal)

1. to the TRAVEL INFORMATION provided at RICT?
2. What is your level of satisfaction with the information provided at RICT on how to find your way around the station and associated transport facilities?
3. What is your level of satisfaction with regard to the following TIME & MOVEMENT aspects inside the interchange?
4. What is your level of satisfaction with regard to ACCESS?
5. What is your level of satisfaction with regard to COMFORT & CONVENIENCE?
6. What is your level of satisfaction with regard to the attractiveness of RICT and associated transport facilities?
7. What is your level of satisfaction with regard to SAFETY & SECURITY RICT?
8. What is your satisfaction with regard to the EMERGENCY PROCEDURES RICT?
9. Please, give a final overall value for your satisfaction with the service at this interchange:
10. Finally, which of the following are in your opinion the 3 most important aspects of an interchange?

New multi-modal transport hub

1. Would it be convenient to use bus station services for your trip to/from Kurzeme and Zemgale destinations if regional bus station will be located in Tornakalns neighbourhood?
2. What kind of public transport or private transport would you need to use to get to / from regional bus station in Tornakalns neighbourhood to get to/from your destination in Riga?
3. Other location of coach terminal or multimodal hub, which will be interesting for you

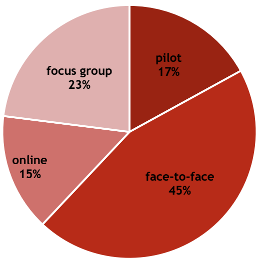
Socioeconomic information

1. Gender
2. Do you have…? (driver licence, bicycle, car)
3. How old are you?
4. Education level
5. What is your employment status?
6. Number of people in your household
7. Personal Net Income per month

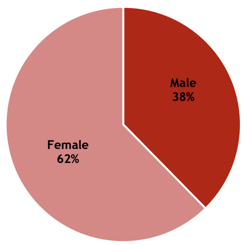
https://goo.gl/forms/H59dcV0hNDXtIECw2

Sample characteristics - 1

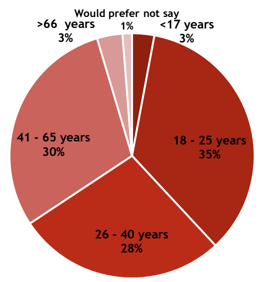
Main survey (239 users)



Gender

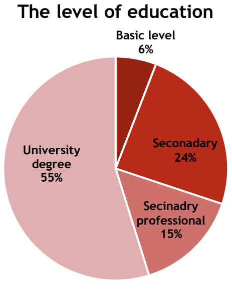


Age

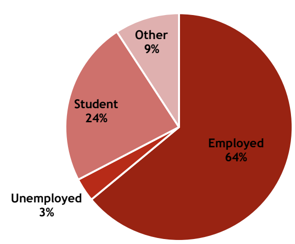


Sample characteristics - 2

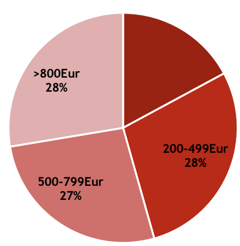
The level of education



Employment status



Personal Net-Income per month



Decision Tree Approach

Weka J48 – Waikato Environment for knowledge analysis: “is a popular suite of machine learning software written in Java”
J48 – is an algorithm to generate a decision tree which is generated by C4.5

Steps to generate the decision tree

- Data base (survey results)
- Data base preparing by obtaining information
- Weka programme

Decision tree approach

Attribute	Code
Availability and ease of use of travel information at the terminal	A1
Availability of travel information (timetables, routes, delays) before your trip	A2
Accuracy and reliability of travel information displays for bus/trains at the terminal	A3
Ticket purchase (ticket offices, ticket machines, etc.)	A4
Signposting to different facilities and services	B1
Signposting to transfer between transport modes in all parts of the terminal	B2
Information and assistance provided by staff	B3
Transfer distances between different transport modes	C1
Co-ordination between different transport operators or transport services	C2
Use of your time (transferring & waiting) at the terminal	C3
Distance between the facilities and services	C4
Ease of movement due to number of people inside the terminal	C5
Ease of access to the terminal	D1
Ease of access from the terminal	D2
General cleanliness of the terminal	E1
Temperature, shelter from rain and wind, ventilation, air conditioning	E2
General level of noise of the terminal	E3
Air quality, pollution (e.g. emissions from vehicles)	E4
Number and variety of shops	E5
Number and variety of coffee-shops and restaurants	E6
Availability of cash machines	E7
Availability of seating	E8
Availability of mobile phone signal and Wi-Fi	E9
Comfort due to the presence of information screens	E10
The surrounding area is pleasant	F1
The internal design of the terminal (visual appearance, attractiveness, etc.)	F2
The external design of the terminal (visual appearance, attractiveness, etc.)	F3
Safety getting on and off the transport mode (train, bus, taxi, bicycle, etc.)	G1
Safety whilst inside the terminal	G2
Feeling secure in the transfer & waiting areas (during the day)	G3
Feeling secure in the transfer & waiting areas (during the evening/night)	G4
Feeling secure in the surrounding area of the terminal	G5
Lighting	G6
Information to improve your sense of security	H1
Signposting to emergency exits	H2
Location of emergency exits in case of fire	H3
Overall score of user satisfaction with the service in the terminal	I

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Results-1

Overviews of results.

Parameter	Value
Correctly classified instances	89.5397% (214)
Incorrectly classified instances	10.4603% (25)
Kappa statistic	0.83353
Mean absolute value	0.0708
Root mean squared error	0.1882
Relative absolute error	27.294%
Root relative squared error	52.3602%
Total number of instances	239

Detailed accuracy by class.

	TP Rate	FP Rate	Precision	Recall	F-Measure	MCC	ROC Area	PRC Area	Class
	0.000	0.000	0.000	0.000	0.000	0.000	0.989	0.167	1
	0.714	0.005	0.938	0.714	0.811	0.804	0.967	0.839	2
	0.958	0.084	0.885	0.958	0.920	0.865	0.967	0.921	3
	0.931	0.087	0.887	0.931	0.908	0.839	0.961	0.923	4
	0.650	0.000	1.000	0.650	0.788	0.794	0.958	0.805	5
Weighted Average	0.895	0.071	0.896	0.895	0.891	0.839	0.964	0.902	

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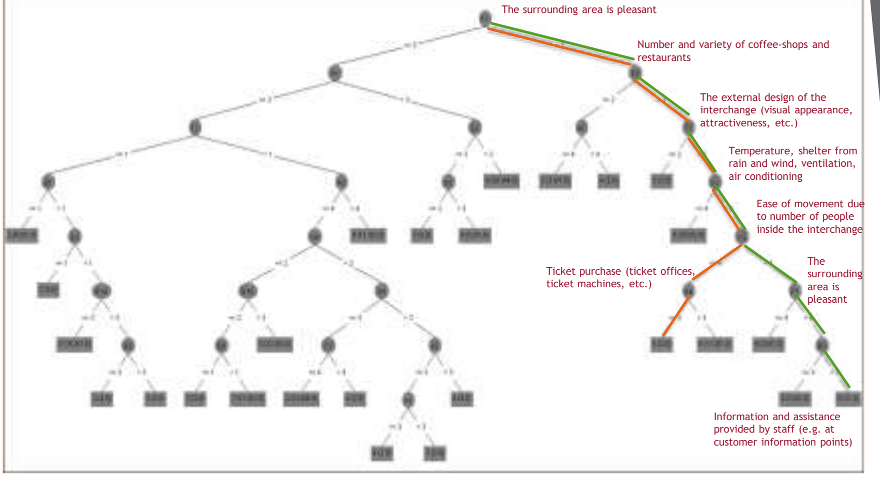
Results-2



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Conclusions

- The goal was to capture the viewpoint and preferences of travelers on different aspects that define the design and operation of sustainable urban transport interchanges
- A classification tree was developed, using one of the most prevalent relevant algorithms-C4.5
- Two paths were prepared with the highest evaluation scores dealing with indicators that improve the general perception of quality in the interchange
- The main difference between them is that the first includes more indicators and is more focused on the perceived hospitability of the interchange facilities and the quality of offered services
- The tree paths indicate the indicators that need higher attention from the side of decision makers for the increase of the overall satisfaction level of users

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Next steps

- Interviews with several Latvian stakeholders
- Development and analysis of alternative decision trees
- Assessment of the impacts of RICT in the urban environment
- Meta-analysis: comparison of the results of this study, with relevant findings of similar surveys realized in 5 European transport interchanges (*submitted to Transport Research Arena Conference TRA 2018*)

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Thank you for your attention!

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MECHANISM FOR INVESTMENT IN THE TRANSPORT INFRASTRUCTURE DEVELOPMENT IN LATVIA

Dr.oec, prof., Irina Kuzmina-Merlino
Dr.-Ing. Fabian Behrendt
MSc, PhD student, Oksana Skorobogatova
MSc, PhD student, Niels Schmidtke
Transport and Telecommunications Institut, Latvia
Fraunhofer Institute for Factory Operation and Automation IFF, Germany

This project has received funding from the *European Union's Horizon 2020 research and innovation programme* under grant agreement No 692426

Young Researchers' Seminar: "Sustainable Transport Interchanges"
20-21 October 2017, Riga, Latvia

Background:

Well-developed and efficient infrastructure is crucial for ensuring the effective functioning of the economy. A considerable lack of industry financing certainly affects the assessment of the quality of the overall infrastructure in a global context

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The goal & objectives

- *to develop a conceptual approach to the creation of an investment mechanism for Latvia, based on the experience of Germany and other countries having a high rating of the quality of the overall infrastructure.*

- the study focuses on studying the following issues:

1) Transportation infrastructure investment performance in Latvia and Germany.

2) How are the investments financed? How to bridge infrastructure financing gap?

3) Mechanism for improving the management process of investment decision making in transport infrastructure.

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Logical structure of the research

Research object	The aim	Method	Result
Transport infrastructure investment performance in Latvia and Germany	To identify financial gap between the needs and the amount invested	Comparative analysis of investments and quality of infrastructure	It's necessary to develop a conceptual approach for making an effective investment decision.
Infrastructure financing sources mechanism of investing	To understand how to bridge financing gap?	Literature review	Identification of the form of financing and problems in investing process
How to invest? How to rich the effectiveness of investing?	To understand how investment mechanism is working?	Case studies: Experience of Germany and the UK	Conclusion about necessity to develop investment mechanism in Latvia
The concept to support the process of investment decision making	To design the conceptual model of investment decision-making	Logical-conceptual approach based on ROAMEF cycle ("Green Book, UK"; "White book, EU"; PPP Germany	Conceptual model to building investment mechanism in Latvia and Investment decision-making concept

Transport infrastructure investment performance in Germany and Latvia

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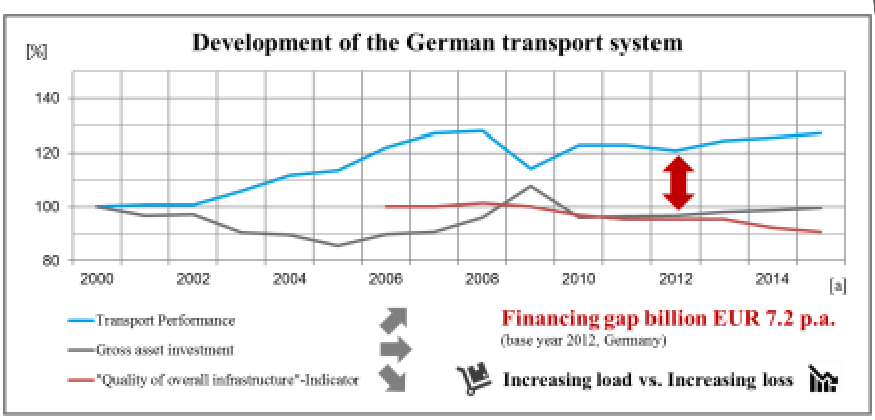
Development of the **German** transport system



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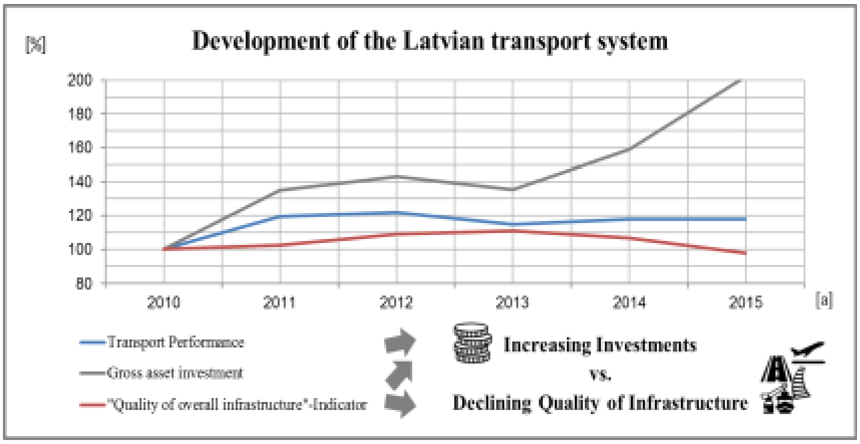
Development of the **Latvian** transport system



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Conclusion:

An analysis of available economic and scientific literature has made it possible to identify problems in the financing of transport infrastructure, which in most cases are common to many countries; the most urgent problem is the gap between the need for financing the infrastructure and the available financial resources.

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Public- private partnerships (PPPs): case from Germany

Within PPPs the contracting authorities (public sector) conclude a long-term contract with a private partner as contractor.

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Public Private Partnership-Models for Federal Highways

Public Private Partnership-Models for Federal Highways

A-model (Expansion)	V-model (Availability)	F-model (Special constructions)
Since 2005	Since 2009	Since 1994
Expansion, operation, maintenance and pro rata financing	Expansion, operation, maintenance and (pro rata) financing	Construction, operation, maintenance and (pro rata) financing (bridge, tunnel, mountain passes)
Forwarding of the collected toll (risk)	Construction contract, payment independent of traffic volume	Collecting a toll from all users, toll rate setted by customer
User orientation (dependence on traffic volume)	User orientation (dependence on availibility)	User orientation (dependence on traffic volume)
Term of 30 years	Term of 20 to 30 years	-
Pilot projects: A8 Augsburg – Munich A1 Bremen - Hamburg	Pilot projects: A9 Lederhose – federal state boundary Bavaria	Pilot projects: B103n Rostock B103 Lübeck

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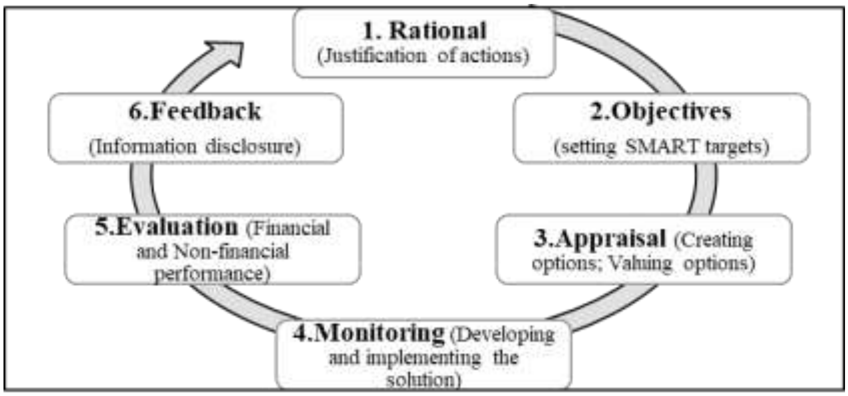
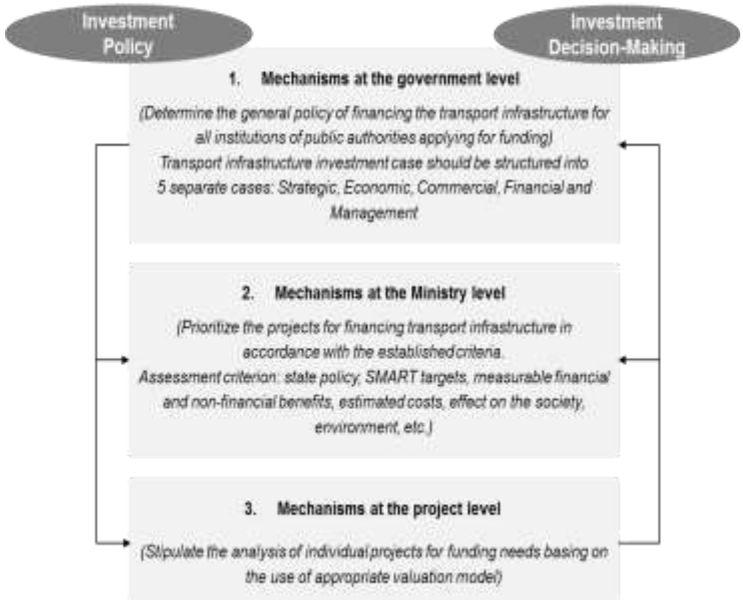
ROAMEF cycle



developed by the authors, based on the 'Green Book'

Conceptual approach to building investment decision-making mechanism

developed by the authors basing on PwC model and 'Green Book'



Investment Decision-Making Concept

developed by the authors basing on commission's fund structure and COSIMA model

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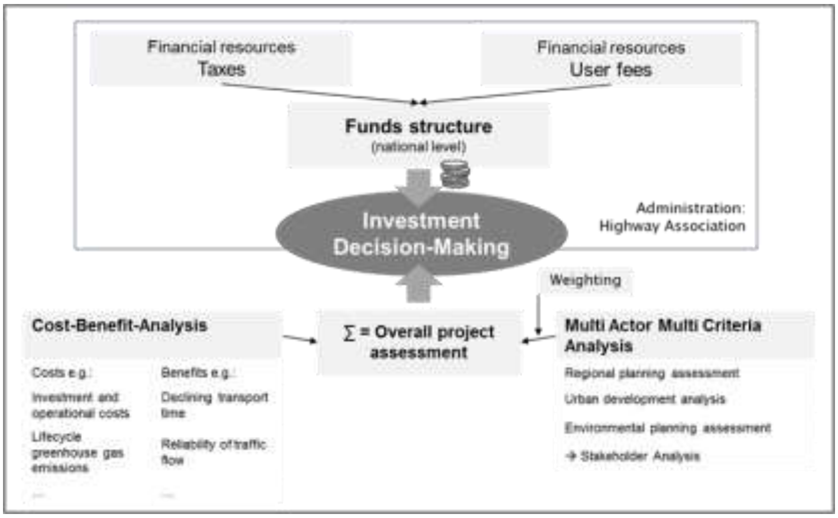

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Conclusions (1/2):

1) The role of the state in funding the transport sector remains the leading one, but it becomes obvious that the state cannot withstand the growing requirements for financing this sector. Public private partnerships are seen as an efficient way of financing the transport infrastructure.

2) The lack of an orderly investment mechanism was called by the European Commission among the most serious problems of implementing the investment policy in the development and maintenance of the transport industry.

3) The investment mechanism includes all levels of investment decision-making in the development and maintenance of transport infrastructure in accordance with the investment policy of the state and allows coordination of the investment policy of the state with the available financial resources.

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Conclusions (2/2):

4) The development of an investment mechanism and related tools can help Latvian politicians make a decision about the agents able to implement a particular project more efficiently – the state or the private sector.

5) Investments in transport infrastructure may be attractive for private investors, but only if the investment project developed on the basis of the adopted business model is attractive itself. The essence of the investment mechanism is to help find the most profitable investment solution and the most efficient way of financing an investment project.

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Thank you for your attention

Dr.oec, prof., Irina Kuzmina-Merlino
Dr.-Ing. Fabian Behrendt
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Conceptual approach to building investment decision-making mechanism

- At the level of the government of the country (the 1st level), the investment mechanism determines the general policy in the context of the state strategy for the various government agencies applying for funding; for example, the amount of funding necessary for the development and maintenance of the transport sector is determined. As a matter of principle the planning authority as well as the legislature's competences for the interests of transport policy belongs to the national government, with EU White Paper setting out the guidelines for European transport policy.

- Basing on the national priorities, officials of the Ministry of Transport determine the financial mechanism for investing in the projects of transport infrastructure development (the 2nd level). The officials rely on the developed criteria (public policy, performance indicators, and needs of the society) in the process of working.

- At the project level (the 3rd level), the individual projects compete for receiving financing for the development of transport to solve a specific transport problem. At this level, the models of assessing the viability and long-term nature of the project are of fundamental importance.

A thorough review of Big Data Sources and Sets Used in transportation research

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This project has received funding from the *European Union's Horizon 2020 research and innovation programme* under grant agreement No 692426

Young Researchers' Seminar: Sustainable Transport Interchanges
20 October 2017, Riga, Latvia

Outline

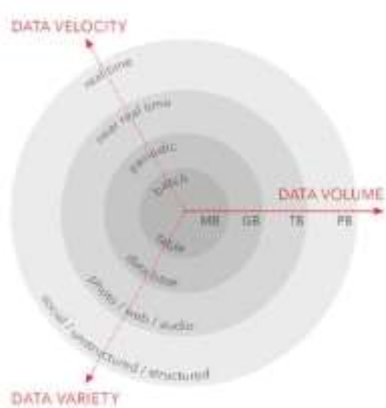
- Big Data
  - Big data types in transport
    - GPS data
    - Mobile phones
    - Smart Card data
    - Social media
    - Points of Interest
- Review of data sources and analysis
- Conclusions
- References

Big data refers to all those data whose scale, diversity and complexity require new analysis techniques and algorithms (Chandrasekar, 2015).

Big Data

"3 Vs"

- High Volume
- Velocity
- Variety



Source: PTV Group

- ✓ Value
- ✓ Veracity
- ✓ Validity
- ✓ Volatility

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Big Data

Potential benefits of Big data in transport:

•Reduction of infrastructure costs

•Reduction of congestion

•Improvement of travelers information and traveler assistance service

•Better understanding of commuters' needs

•Increase of road safety

•Enhancement of the overall efficiency

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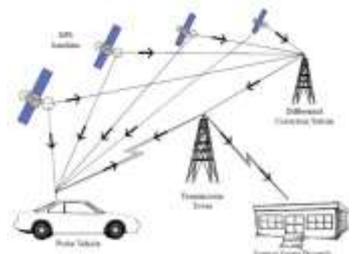
Big data types in transport

Source: Google images

GPS data

Floating car data→ dynamic sensors fleet

- Average speed- estimation of traffic situation
- Origin – Destination matrix estimation
- Mobility patterns
- Taxi/bus performance indicators



Source: FHWA report, 1998

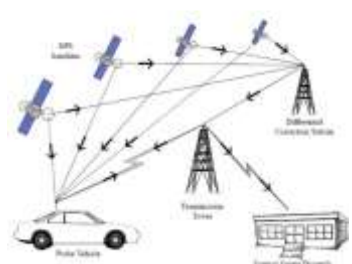
GPS data

Advantages

- Passive collection (no participation of user required)
- Accurate location information
- High sampling frequency
- Large sample size of public vehicles (i.e. taxis)

Disadvantages

- Lack of social-economic, demographic, or social network information about users
- Small sample size of private vehicles or individuals
- High transmission costs



Source: FHWA report, 1998

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Mobile phones

- Collection of mobile phone data by network carriers
- More accurate estimation of the location (home, work, leisure activities)
- Origin – Destination matrix estimation/ Mobility patterns
- Rich sample of residents

Source: Google image

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Mobile phones

Advantages

- Low cost
- Large sample
- Broad spatial and temporal coverage
- Long observation periods

Disadvantages

- Missed travel activity between two phone activities, spatial uncertainties
- Lack of social-economic or demographic information
- Not suitable for estimating travel time on roads
- Sparse and noisy measurements
- Privacy issues

Source: Google image

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Smart card data

The main reason for the introduction of a smart card system for public transport is the secure fare collection

- Card ID
- Transportation mode (bus, metro)
- Route
- Boarding/ alighting times as well as boarding/ alighting stations

→ Mobility patterns

Source: Google image

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Smart card data

Advantages

- Identification of transport mode
- Large volumes of personal travel data
- Access to continuous trip data covering longer periods of time
- Credible reflection of transit demand

Disadvantages

- Constrained to specific traffic mode
- Sometimes unknown destination stop because passengers are required only to check in
- Scarce location-related information

Source: Google image

Social media

Social Media data

geolocated tweets, comments, photos, videos, check-ins

- Activity patterns estimation
- Events / incidents detection
- Attraction models estimation
- Two-way information sharing between the user and the system
- Social media also work as a means for collecting ideas e.g. through Twitter "polls"

Source: Google images

Social media

Advantages

- Exact location of user
- Large sample of qualitative data i.e. social-economic, demographic, and social network information, preferences, intentions, behavior
- Highly active data
- Useful data for evaluation stages
- Low cost

Disadvantages

- Lack of travel information between two active posts
- Unknown transport mode
- Increase of fake and bot-accounts

Source: Google images

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Points of Interest

- Business and important places to visit in a city
- Sources:

- Yellow Pages, Google Places, Yahoo PlaceFinder, which might provide different information.

For example:

In Google Places we can find additional information about opening times, reviews and hourly-estimates on the crowdedness of a place.

-crowdsourcing platforms and social networks (e.g. Foursquare, Flickr, Twitter, etc.).

Source: Google images

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Points of Interest

Advantages

- used as a supplement to other sources
- low cost
- easily accessible

Disadvantages

- limited information
- cannot be used autonomously

Source: Google images

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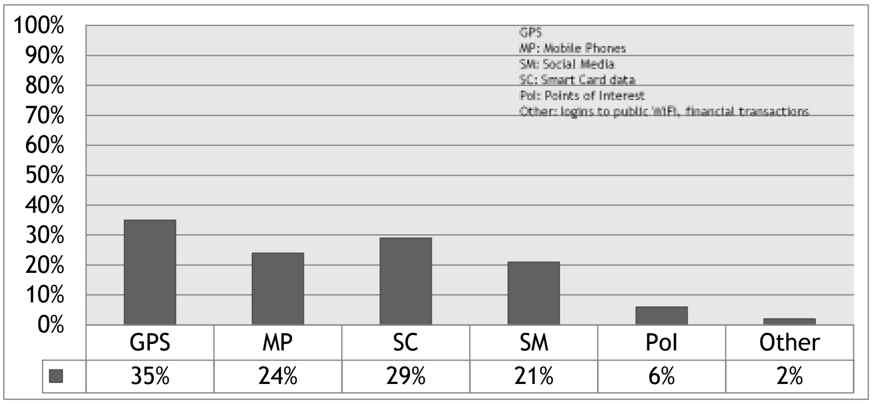
Review of data sources and analysis

The goal of this review is to identify the most frequent big data sources used in transport and disclose in which application field these sources have contributed the most.

- ✓ 63 studies of the last 10 years are analyzed



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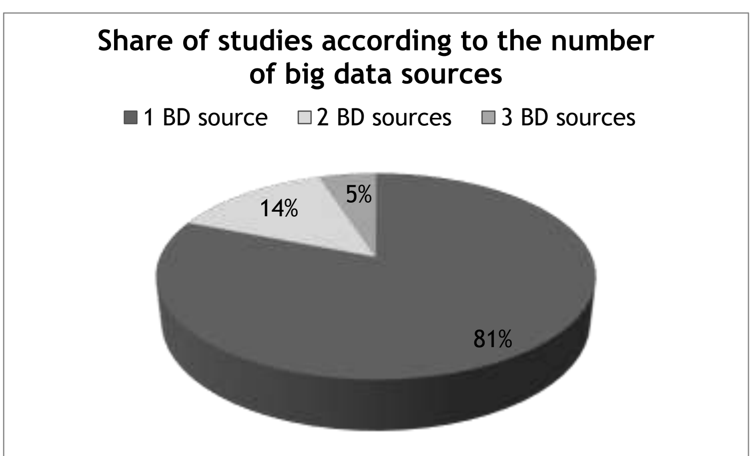
Review of data sources and analysis



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Review of data sources and analysis

Studies that used more than 1 BD source

- 42% of the studies use big data along with data from point detectors
- 50% of the studies use data from social media or Points of Interest as a supplement to other big data sources
- 67% of the studies used GPS data along with another big data source
- 33% of the studies used smart card data along with another big data source

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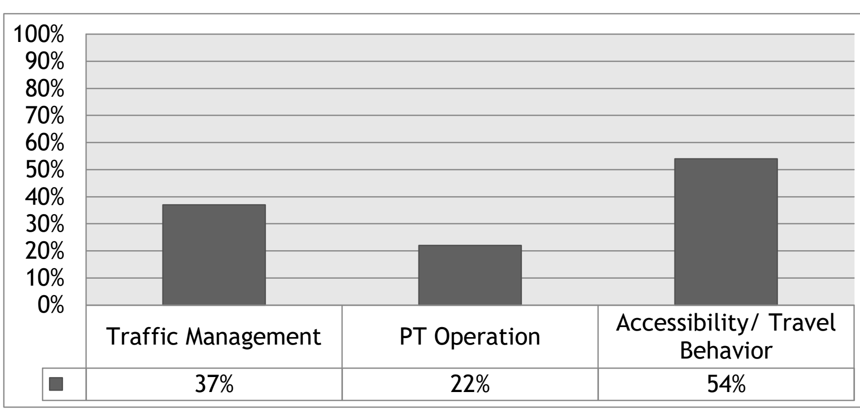
Review of data sources and analysis



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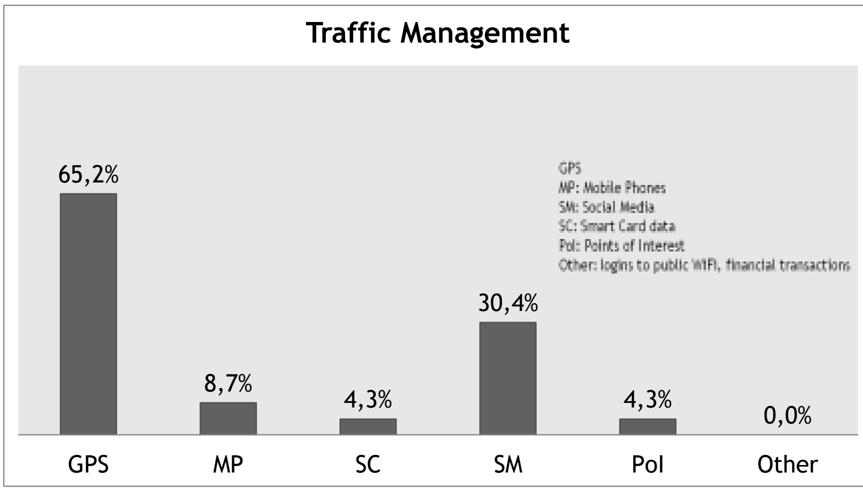
Review of data sources and analysis



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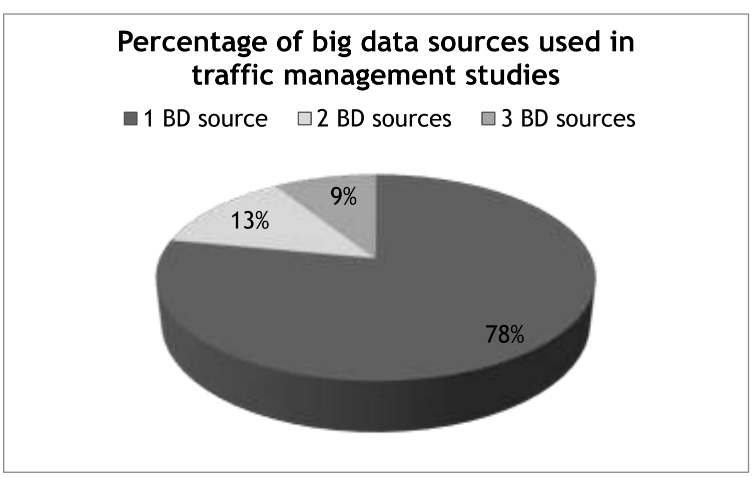

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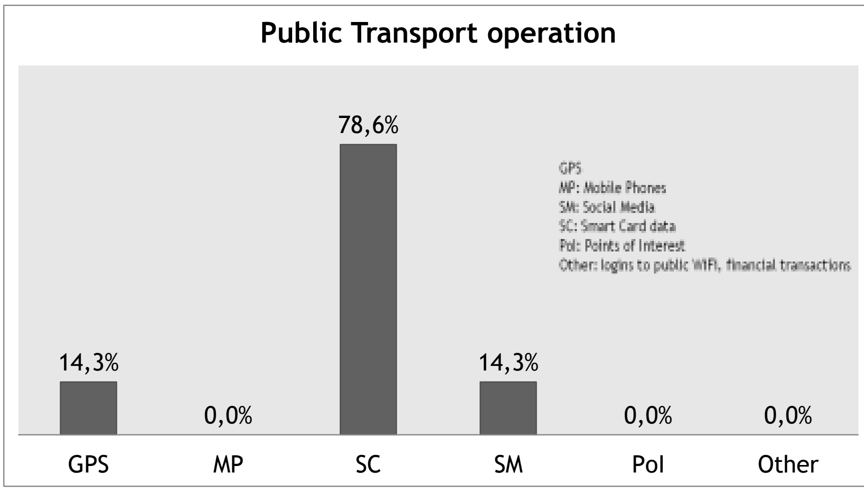

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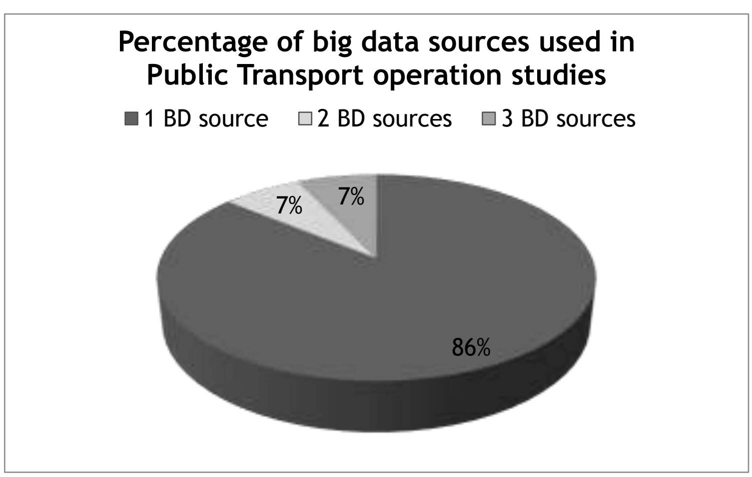
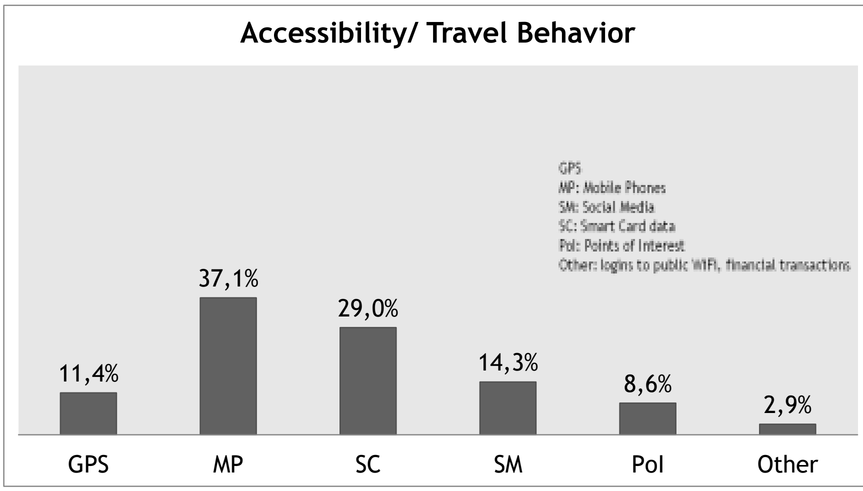
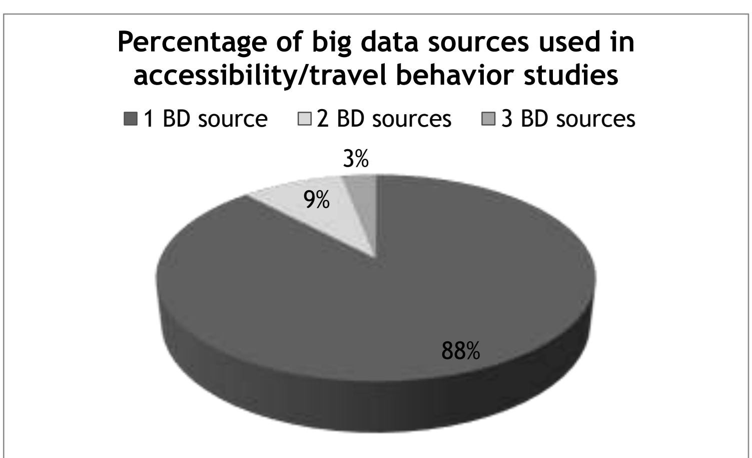


Review of data sources and analysis



Review of data sources and analysis



Conclusions

- ✓ The most frequent big data source is GPS in traffic management, smart card data in Public Transport studies and mobility phone data in accessibility/ travel behavior studies
- ✓ In most of the cases, the extracted big data were oriented to enhance accessibility and examine the travel behavior
- ✓ Data from social media is mainly used to enhance data from other big data sources
- ✓ Further analysis is needed for the better understanding of qualitative big data sources

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Thanks for your attention!

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Evaluating Smart Urban Freight Solutions Using Microsimulation

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This project has received funding from the *European Union's Horizon 2020 research and innovation programme* under grant agreement No 692426

Young Researchers' Seminar: Sustainable Transport Interchanges
20 October 2017, Riga, Latvia

Aim and steps

evaluation of 3 smart urban freight transport measures by using microscopic traffic simulation

- Urban Freight Measures
- Simulation
- Evaluation
- Evalog

Case Study: Volos Commercial Port

Which measures?

- soft measures
- measures that can be simulated in a traffic simulation tool

! Measure selection is limited to the restrictions of the study area

Why simulation?

- provides a safe way for decision makers to test and explore a proposed measure

Why traffic simulation?

- easy and accurate to evaluate traffic and environmental impacts

Why micro-simulation?

- considers detailed parameters such as the infrastructure, local driving regulations, driving behavior parameters

How to evaluate?

- by using traffic and environmental indicators
- for the years 2017 and 2030 in order to ensure sustainability

Why Evalog?

- computes a single index that incorporates the information from all indicators

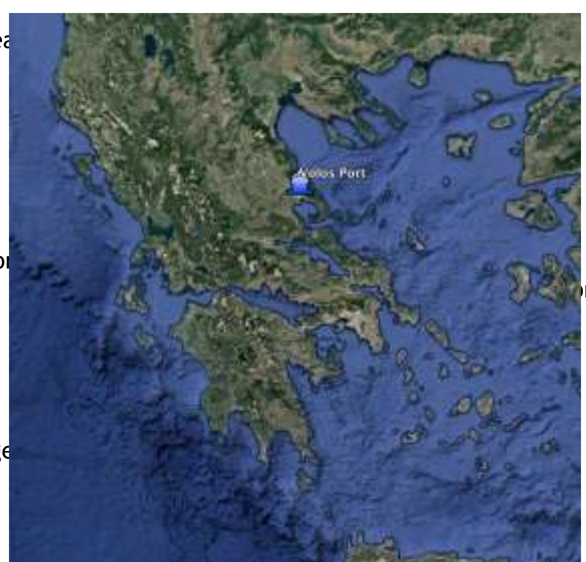
5

Study area

Industrial area

Modeled corridor

Interchange



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Model design

- Volumes and vehicles' composition (counted on 07/06/2017 by observation) in 5 spots
- Peak hour (09:45-10:45)
- Google maps or on-site observation

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Model calibration

- Speed distribution
- Reduced speed areas
- Car following parameters

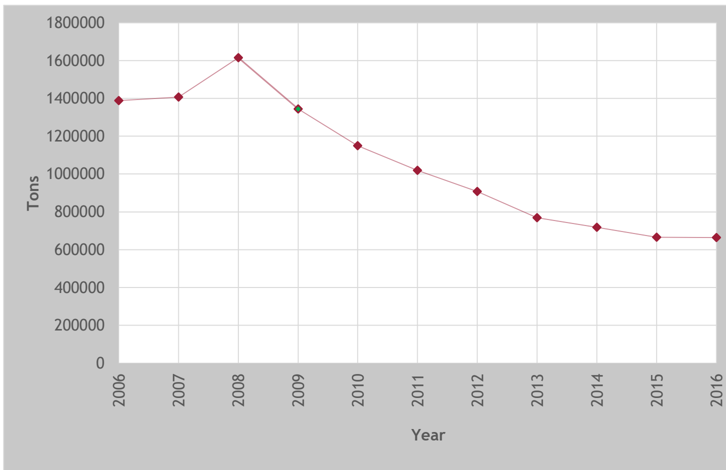
Number of Trials	GEH Value
Trial 1 (Model Default)	5.1
Trial 2 (Calibration 1)	5.6
Trial 3 (Calibration 2)	4.2
Trial 4 (Calibration 3)	4.3
Trial 5 (Calibration 4)	4.1
Trial 6 (Calibrated Model)	3.6 (Threshold: GEH<4 for total flows [7])

$$\text{GEH}=\sqrt{\frac{2(M-C)^2}{M+C}}$$

- M hourly traffic volume exported from the model
- C hourly counted volumes

8

Cargo shipment loads at Volos commercial port



Source: [1]

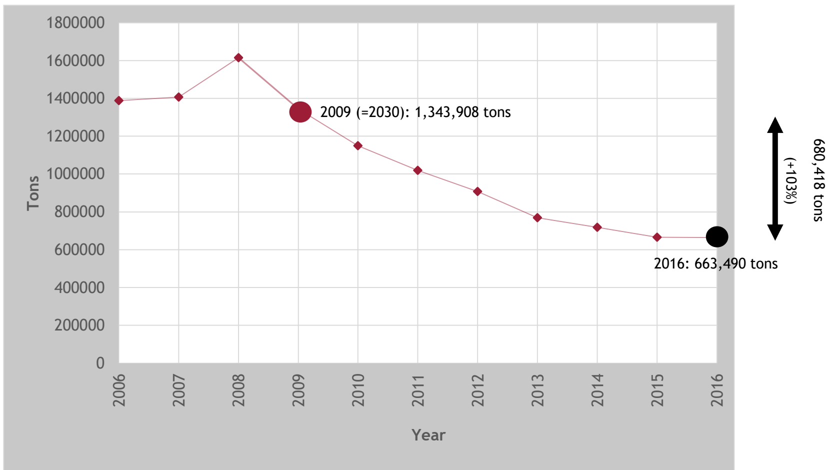
Situation in 2030

<u>Computation of future traffic volumes</u>

1. growth of the city
   - $F = P(1+r)^n$: *F* is the future volume, *P* is the present volume, *n* is the number of years and *r* the growth factor per year.
   - ✓ Growth factor= 0.5 [1]

2. a further development of the port is anticipated by 2030 [2]
   - in 2030 the cargo volumes are expected to be equal to the volumes of 2009 (1,343,908 tons) [4]
   - ✓ number of HGVs entering/exiting the port will increase by 103%

Cargo shipment loads at Volos commercial port



Source: [1]

Logistics Measures

1. **Increasing HGVs load factor** (Measure 1)
   - the average load factor for HGVs approaches 85% [1]; information systems and better programming could end up to an average 95% load factor
   - ✓ 5.5% reduction of HGVs entering/exiting the commercial port
     - ✓ 2017: -2 HGVs / hour
     - ✓ 2030: -18 HGVs / hour

2. **Alternative Fuel Vehicles** (Measure 2)
   - ✓ increasing the share of HGVs that are powered by alternative fuels by 5%
     - ✓ 2017: Diesel HGV: 95%, Compressed Natural Gas HGV: 0.5%, Electric HGV: 4.5%
     - ✓ 2030: No evaluation

3. **Enforcement and ITS adoption for control and traffic management** (Measure 3)
   - Improvement of the “green wave” (+ Cooperative Intelligent Transport System Services)
   - ✓ offsetting earlier the signal program of the last two intersections
     - ✓ 2017: 4 and 5 seconds
     - ✓ 2030: 8 and 6 seconds

Evaluation

- Transport Indicator
  - VISSIM: Delays (s) to a 1410 m section of the corridor (Corridor length:1495 m)
- Environmental Indicators
  - EnViVer: CO_2 (g/km), NO_x (g/km), particle matter - PM_{10} (mg/km) (all network)

Parameters	Values [3], [5] and [6]	
Road Type	Urban	
Vehicles newer than 1 year: %	5%	
Average vehicle age: (years)	13.5	
Average exit age (years)	27	
Euro legislation introduction:	Euro 1 - 1993 Euro 2 - 1996 Euro 3 - 2000 Euro 4 - 2005 Euro 5 - 2009 Euro 6 - 2014	
Vehicle Type: Heavy-Duty	<u>2017</u> Petrol: 0% Diesel: 100% CNG: 0% Electric: 0%	<u>2030</u> Petrol: 0% Diesel: 78% CNG: 2% Electric: 20%
Vehicle Type: Light-duty	<u>2017</u> Petrol: 92.53% Diesel: 6.41% CNG: 1.05% Electric: 0.01%	<u>2030</u> Petrol: 79.55% Diesel: 6.41% CNG: 1.05% Electric: 1.82%

Analysis

Case	CO_2 (g/km)	NO_x (g/km)	PM_{10} (mg/km)	Delays (s)
Year 2017				
Base model	338543	1212	67918	39
Measure 1	336512	1210	67714	38.5
Measure 2	334112	1176	66575	39
Measure 3	332409	1198	67377	36.1
Year 2030				
Base model	456453	2113	104317	75.8
Measure 1	436538	1985	98267	62.7
Measure 3	428604	1987	98678	46.9

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Measure comparison

Ranking	Measure	CO_2	NO_x	PM_{10}	Delays	LSI change
Year 2017						
1st	Measure 3	-1.8%	-1.2%	-0.8%	-8.6%	4.7%
2nd	Measure 2	-1.3%	-3.0%	-2.0%	0.0%	1.0%
3rd	Measure 1	-0.6%	-0.2%	-0.3%	-2.5%	0.8%
Year 2030						
1st	Measure 3	-6.1%	-6.0%	-5.4%	-38.1%	28.2%
2nd	Measure 1	-4.4%	-6.1%	-5.8%	-17.3%	12.7%

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Future research

- extension of the current network up to the industrial area
  - ✓ better estimation of the total changes in the area due to measures' implementation
  - ✓ a test bed to evaluate additional solutions
- coupling VISSIM with AnyLogic simulation software that deal with intra-logistics processes
  - ✓ simulation of the arrival, unloading, storing and loading to HGVs processes of the cargo
  - ✓ evaluation in other impact areas i.e. economy and energy
  - ✓ holistic assessment of a solution

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Thank you for your attention!

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Wide-scale transport network microscopic simulation using dynamic assignment approach

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Contents

- Introduction
- Simulation object
  - Current state of the network
  - Input data for simulation
- Initial model development
  - Definition of model supply data
  - Definition of model demand data
- Dynamic assignment application and results
- Conclusions

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Goal of the research

- To present a case-study from the city of Riga (capital of Latvia)
  - which demonstrates the application of dynamic assignment approach in the complex network simulation and
  - results in some recommendations based on this case-study implementation

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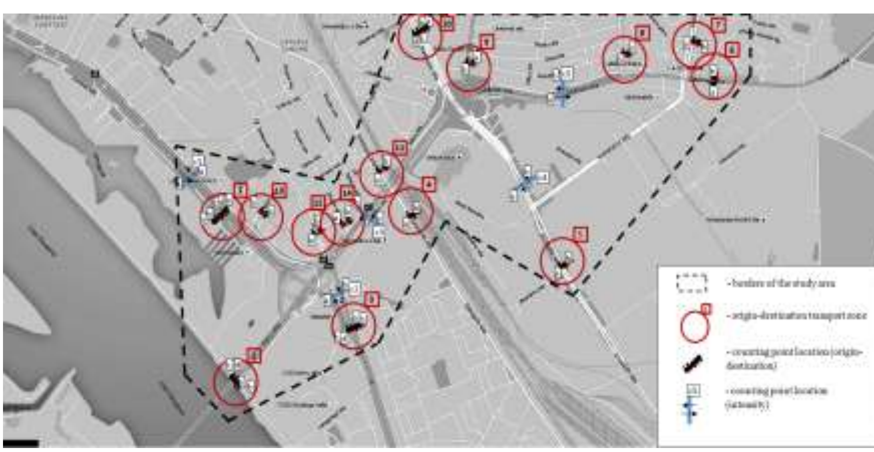
Simulation object



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Current state of the network

Congestions during morning peak hour (Google Maps,2016)

Congestions during evening peak hour (Google Maps,2016

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Initial model development

- Defining background
- Description of the vehicles types
- Traffic flows composition
- Network modelling
- Traffic flow input data modelling
- Routing decisions and routes definition
- Public transport definition
- None-signalized intersection definition
- Signalized intersection definition
- Output data definition
- 2D/3D model development

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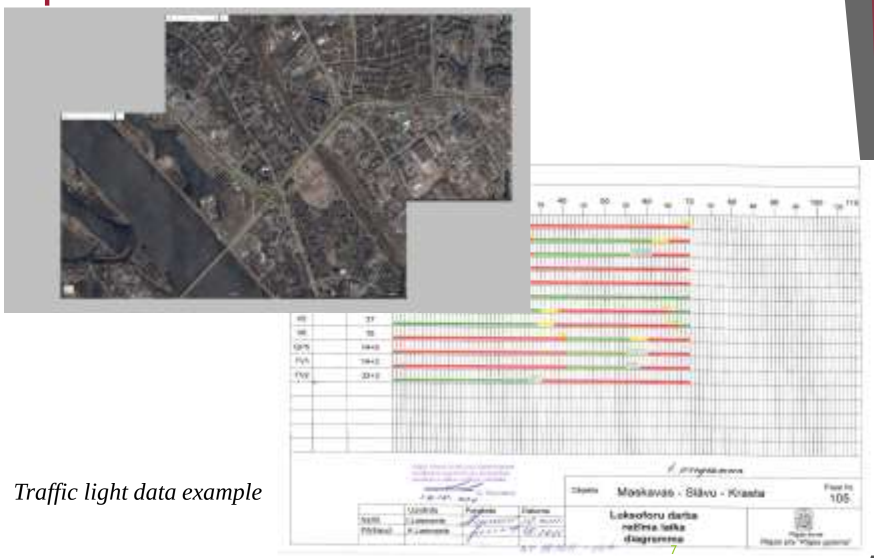
Input data



Traffic light data example

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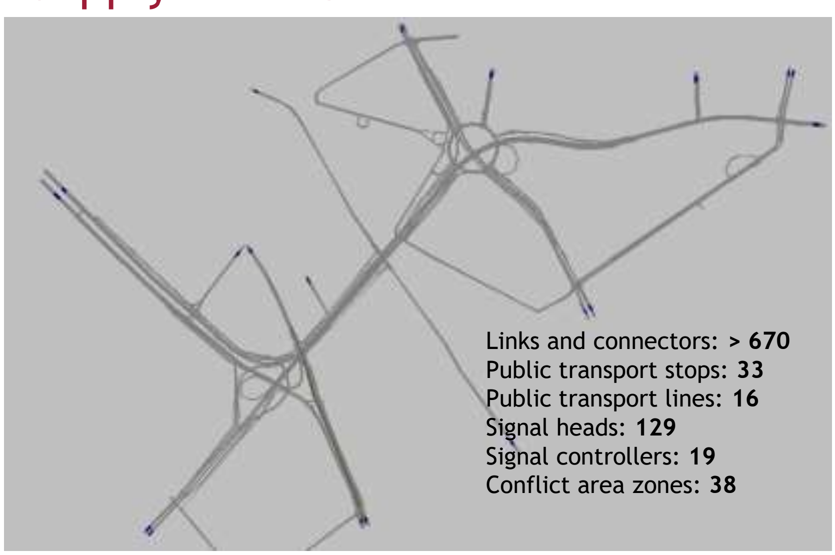
Supply data: Coded network



Links and connectors: > **670**
Public transport stops: **33**
Public transport lines: **16**
Signal heads: **129**
Signal controllers: **19**
Conflict area zones: **38**

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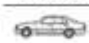
Demand data

- OD matrix for each type of the vehicles:

Graphical representation	Code	Description
	V	Passenger vehicles
	C1	Light cargo vehicles
	C2	Mid cargo vehicles
	C3	Cargo vehicles

- Each OD matrix is defined for 1h15m

- 14 zones (described by 28 parking lots)

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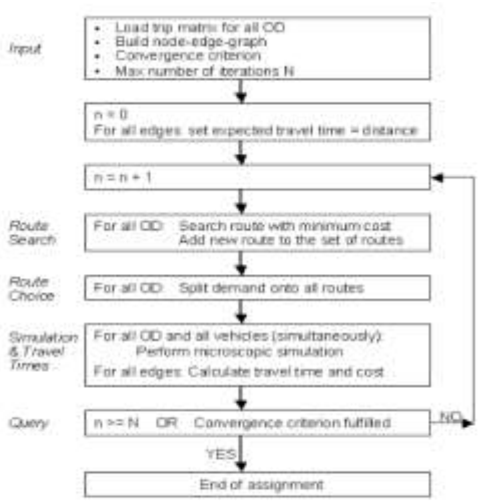
General principle of the dynamic assignment



Found recommendations for DTA in VISSIM (1/3)

- **Default parameters**
  - It is recommended to use VISSIM defaults parameters for dynamic assignment initially. Do not change default values, if you are not sure about the influence of the parameters on dynamic assignment procedure. In most cases, the options described below could give satisfactory results
- **Multirun simulation options**
  - The random seed increment option should **be set to 0**, in the case of applying dynamic assignment
- **Dynamic assignment volume increment**
  - If the simulated network is heavily congested, it is recommended to **apply dynamic assignment with volume increment**. It is recommended to **start with 30%**

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Found recommendations for DTA in VISSIM (2/3)

- **Convergence criteria**
  - VISSIM provides the following convergence conditions: Travel Time on Paths, Travel Time on Edges, Volume on Edges. **Travel Time on Paths** option is recommended in most cases. The tolerance values of **15%** are recommended (default value).
- **Local calibration**
  - The cost of VISSIM links and connectors can be increased or decreased using surcharges. Surcharges are added to the total cost once per visit of a link/connector section. It is recommended to apply **Surcharge 2** as it provides more visibility to the calibration procedure. Recommended to start with a surcharge value of **30**
  - **Surcharge 1** could be recommended if there are problems with **specific types of the vehicles**, which are selecting not realistic paths (at example cargo vehicles)
  - The more rigid methods, available in VISSIM, **as Edge closure and Route closure**, are not recommended for practical use

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Found recommendations for DTA in VISSIM (3/3)

- **Restricting the Number of Routes**
  - There are 2 options for restricting the number of routes: Defining an upper limit for the number of routes; Defining a maximum of the cost difference between the best and the worst route
  - The use of the Path search options highly depends on the network, which has been simulated.
    - If there are only a few realistic routes from zone to zone, the definition of the upper limit of routes could give a positive result
    - If for some OD pairs exist a significant number of routes and they are used and at the same time for some OD pairs only a few routes exist, it is recommended to define a maximum of the cost difference between the best and the worst route
- **Costs coefficients**
  - Cost coefficients are an effective way to influence the behaviour of vehicles of different types. If the analysis of the traffic flows circulation shows the difference in behaviour compare to real situation, it is possible to control the behaviour with providing coefficients for following factors: Travel time, Distance, Link Cost. Usually, the default values give satisfactory results during simulation, if no difference in behaviour could be foreseen

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Validation results

Observation Point	Direction	Simulated Values	Counted Values	Difference, %	GEH
C1	a	2658	2804	5.2	2.7
	b	4649	5016	7.3	5.27
C2	a	3003	3222	6.8	3.9
	b	1846	1967	6.2	2.77
C3	a	4626	4909	5.8	4.09
	b	4960	5267	5.8	4.29
C4	a	1297	1379	5.9	2.24
	b	1136	1223	7.1	2.53
C5	a	1562	1658	5.8	2.39
	b	2157	2302	6.3	3.07

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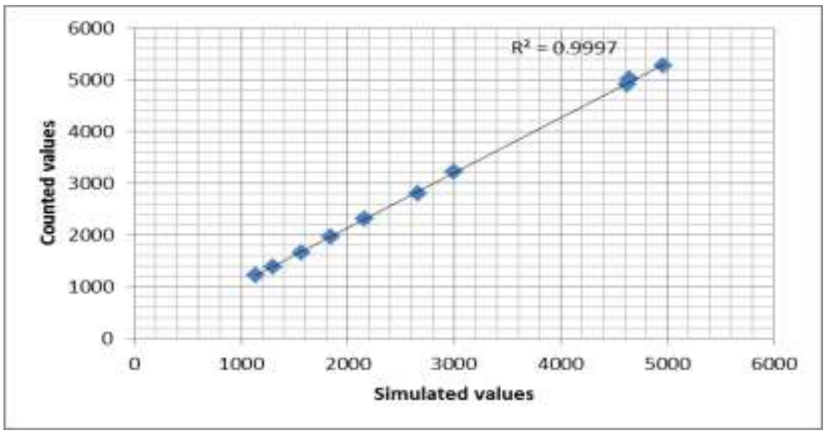
Validation results by NAIVE approach



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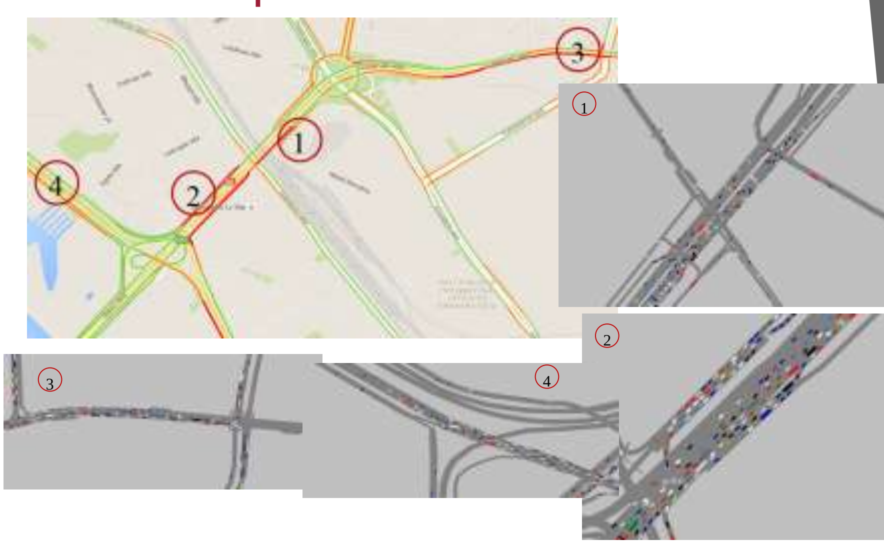
Visual inspection



Conclusions

- The initial model of the study object was developed using VISSIM simulation software, the DTA was used as the study object is complex and includes significant number of crossroads
- The DTA use adds additional complexity to the simulation, to help VISSIM users (researchers and practitioners) the recommendations about DTA use in VISSIM were summarized in the research
- 3 level validation: GEH, Novel and Visual inspection allows to organize validation in effective way from point of view of time and result
- To summarise all validation results, it could be concluded that developed model with DTA is valid and could be used for further research and for application
- Limitations of DTA
  - Higher requirements to the initial data for simulation (OD matrix, data required for validation etc)
  - DTA models take more time and resources to be developed and calibrated (compare to static traffic assignment models)
  - For long-term planning, the available level of input data required for DTA may not be available
  - In some cases, the traffic flow models within a DTA model may produce counterintuitive results that are difficult to explain, because they are the consequence of interactions taking place over the entire network and across multiple time periods

Thank you

$$GEH = \sqrt{\frac{2(M-C)^2}{M+C}}$$

According to the GEH application rules, 85% of the volumes in a model should have GEH less than 5. As could be seen from the data only one value is higher, based on obtained data of GEH

NAIVE approach was used to compare simulated and counted values by constructing the linear regression model between real data and the outputs from the model To evaluate validation results standard regression model quality indicators were used: R^2

$$F_{2,n-2} = [(n-2)/2][SSE_{reduced} - SSE_{full}]/SSE_{full}$$

$$SSE_{full} = \sum_{i=1}^{n} (y_i - \hat{y}_i)^2$$

$$SSE_{reduced} = \sum_{i=1}^{n} (y_i - x_i)^2$$

SSE – sum of squared errors

Experimental Study on Distributed Road Tracking System for Road Traffic Registration

Alexander Dudko
Keio University, Tokyo, Japan
Transport and Telecommunication Institute, Riga, Latvia
2017.10.20

Content

- Current situation on the roads
- Goal of the research
- Proposed system
  - Road Traffic Sensor
  - Central Server
  - Overall System Architecture
- Experiments
- System introduction

2

Current situation

Current situation and Goal

3

Road collisions, injuries and death

- According to the World Health Organization, road traffic injuries caused an estimated 1.24 million deaths per year worldwide
- That is one person is killed every 30 seconds
- The average road fatality rate in European Union (EU) is equal to 51 dead per million inhabitants whereas road fatality rate in Latvia is 222 dead per million people.
- Latvia has the highest road fatality rate among countries of EU.

4

European Union and Japan

Top 10 Fatalities in the World

Rank	Cause
1	Ischemic heart disease
2	Lower respiratory infections
3	Cerebrovascular disease
4	Diarrheal diseases
5	Malaria
6	HIV/AIDS
7	Preterm birth complications
8	**Road traffic accidents**
9	Chronic obstructive pulmonary disease
10	Tuberculosis

Health Diseases (ranks 1–7)

Unintentional (rank 8)

Health Diseases (ranks 9–10)

Why? – Drivers violate road laws

- It is quite common that drivers violate the maximum speed restriction as well as some other road laws
- Current regulation: City police departments usually setup speed radars in a few locations and do some patrol, but it has only local effect, because radars measure speed **only** at single point.
- The current approach is not effective.
- For the purpose of road laws regulation new approaches are required

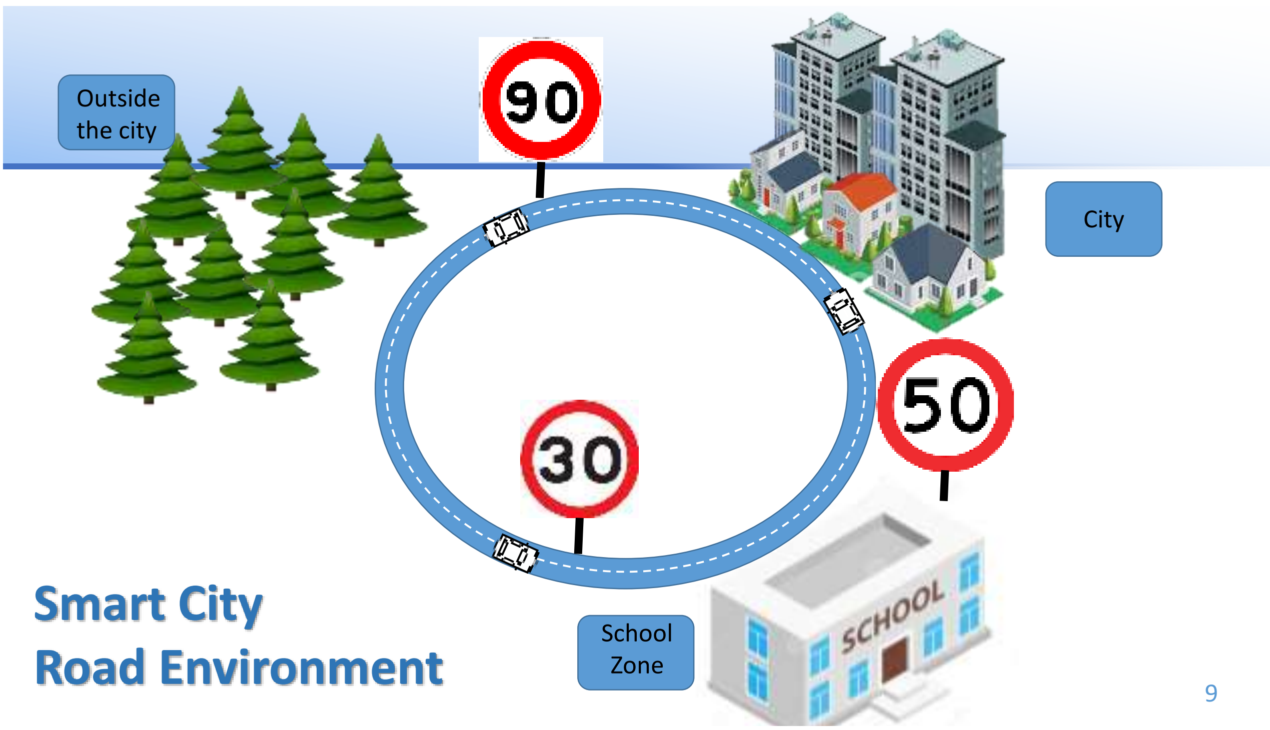
Goals

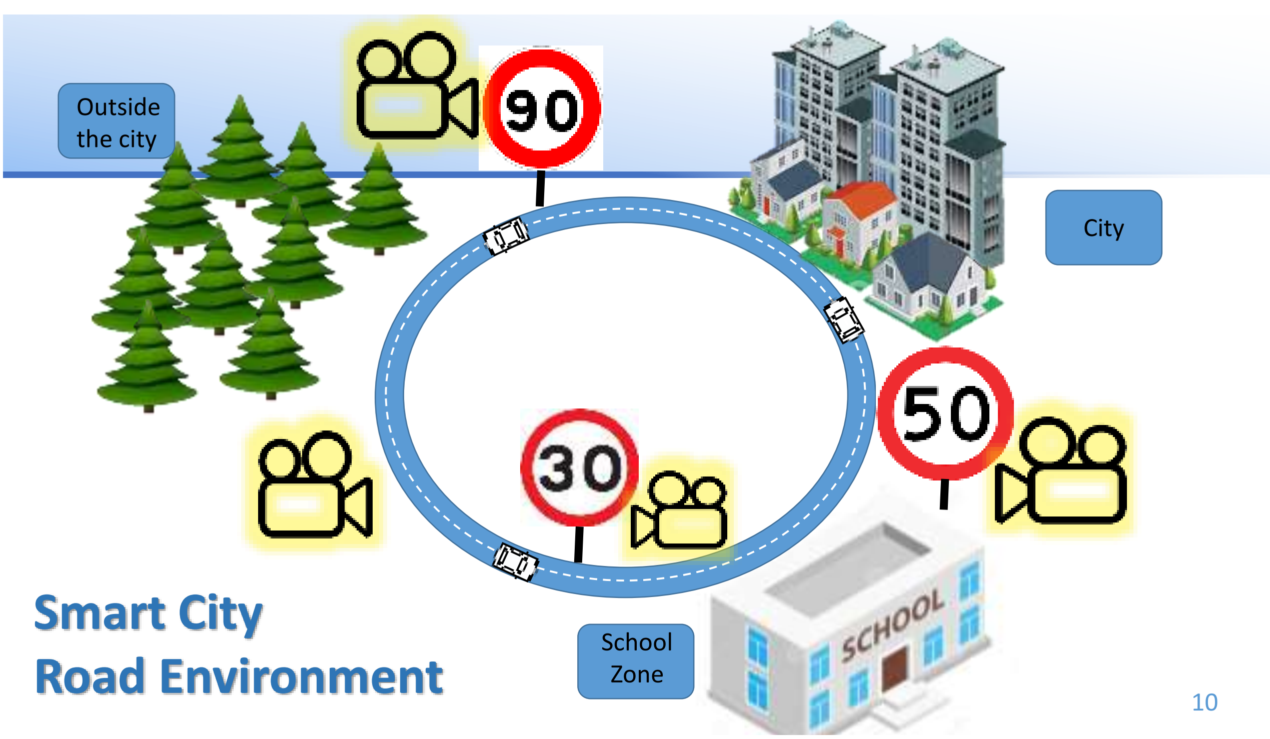
Goal of the project

- Create an innovative Smart City Road Environment System which performs automatic road laws enforcement by means of Semantic Web and Car Recognition from video to improve road safety.

Goal of the current work

- Perform experiments on the roads of Latvia and estimate the potential effect of the proposed system introduction.


Outside the city
90
City
50
30
Smart City
Road Environment
School Zone
SCHOOL
9


Outside the city
90
City
50
30
Smart City
Road Environment
School Zone
SCHOOL
10

Smart City Road Environment

The Smart City Road Environment is a distributed road tracking system which consists of two main parts:

- Road Sensor
  - detect cars
  - automatic car number plate recognition module
- Central Server
  - connects all road sensors together and collects all data
  - centralized processing and analysis
  - central storage

Road Sensor

Road Sensor

- Small and inexpensive device
- Consists of
  - video camera
  - video processing module

- When a car is passed the road sensor, sensor detects the car, takes a picture, and identifies car license number.
- The picture, car number, location and time are stored.

Automatic License Number Recognition

1. **Plate localization** – responsible for finding and isolating the plate on the picture
2. **Plate orientation and sizing** – compensates for the skew of the plate and adjusts the dimensions to the required size
3. **Normalization** – adjusts the brightness and contrast of the image
4. **Character segmentation** – finds the individual characters on the plates
5. **Optical character recognition**

Moving objects detection on the video

- One of the important steps of video processing is scene background estimation.
- Scene background is calculated from fame images by taking into account time between frames.

$$\begin{cases} fr_{bg} = p * fr_{current} + (1 - p) * fr_{bg} \\ p = \exp\left(-k * \left(t_{current} - t_{previous}\right)\right) \end{cases}$$

where fr_{bg} – background frame,

$fr_{current}$ – current frame,

$t_{current}$ – time of the current frame,

$t_{previous}$ – time of the previous frame

p – weight of the current frame (0..1),

$(1 - p)$ – weight of all prev. frames,

k – sensitivity constant

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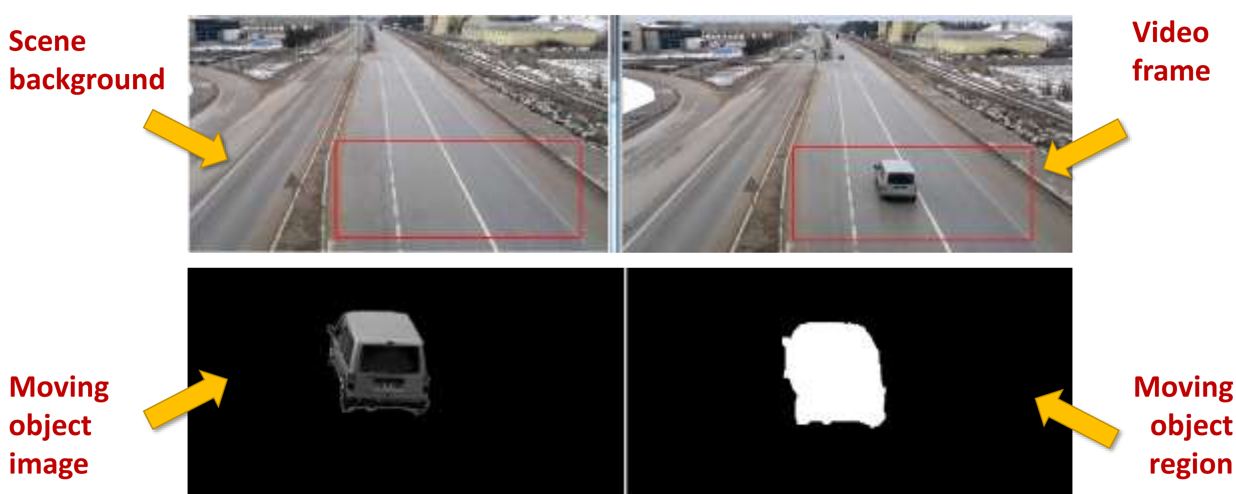
Moving Objects Recognition



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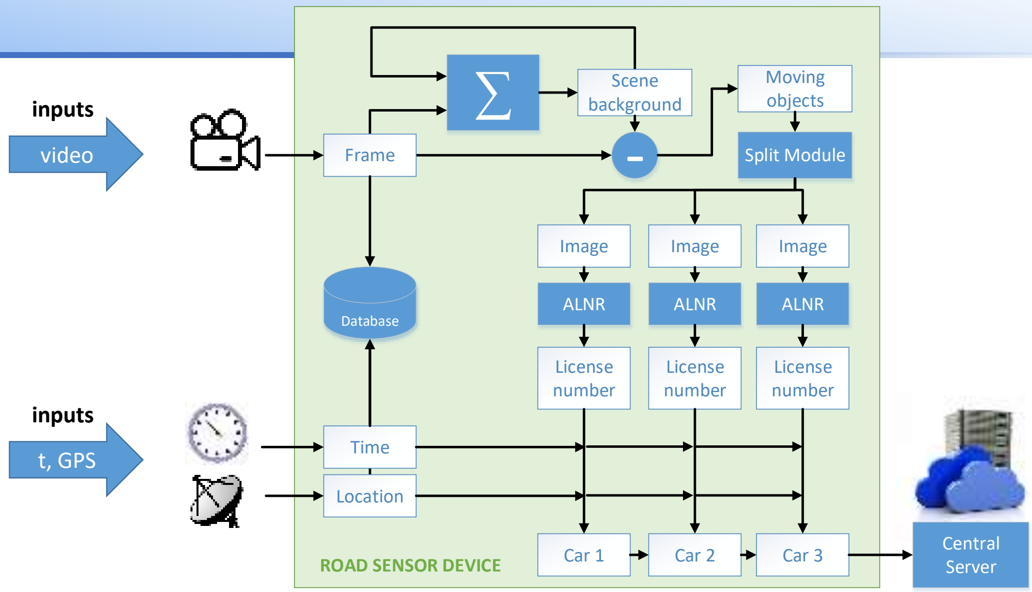
Road Sensor Device Architecture



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Central Server

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Speed calculation – Average speed cameras

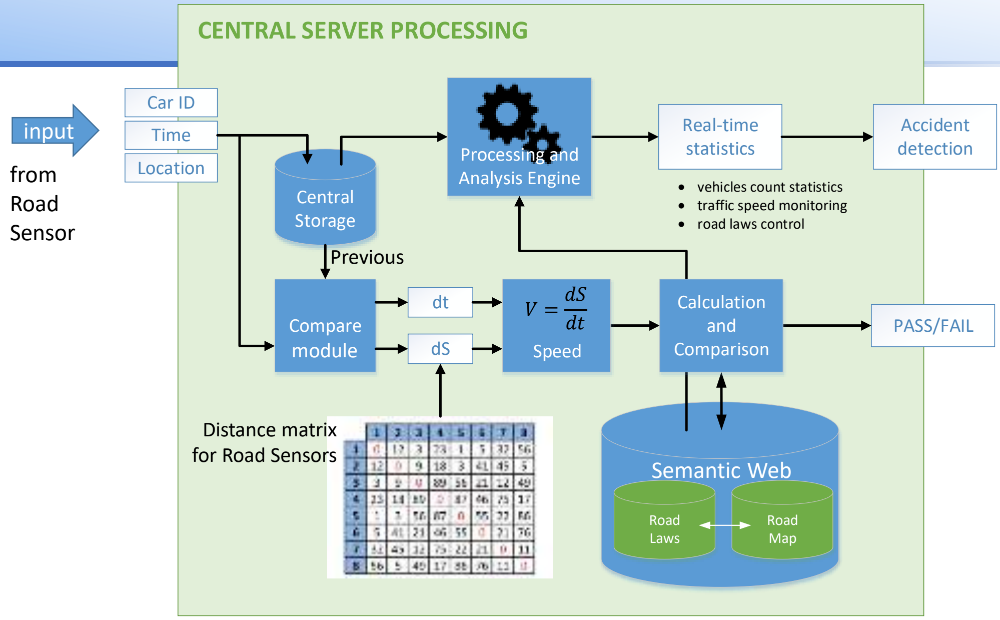
- This works by tracking vehicles' travel time between two fixed points, and calculating the average speed.
- These cameras are claimed to have an advantage over traditional speed cameras in maintaining steady legal speeds over extended distances, rather than encouraging heavy braking on approach to specific camera locations and subsequent acceleration back to illegal speeds.

Speed Calculation Analysis

Speed calculation in the system is performed by the following steps:

1. Car number is received by Central Server from Road Sensor
2. Find previous location and time the car was last seen
3. Determine distance between current and previous points
4. Calculate speed using known distance and time difference
5. Calculate estimated speed measurement error which might me caused by various system components
6. Vehicle speed is compared to roads speed limits

Central Server Architecture



Speed Ticket

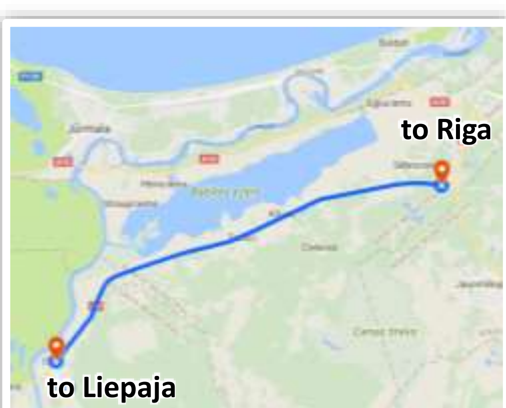
Features of the System

- Road laws enforcement
  - Speed limits check
  - Traffic light check
  - Direction and turns check
- Statistics gathering
  - Vehicles count by areas and time
  - Road traffic speed
  - Source to destination

Challenges

- Sensors locations and camera orientation
  - Maximize road laws checks
  - Minimize number of sensors
- Passing cars detection and identification
  - Moving objects recognition on the video
  - Multi-point tracking by car number, model, color, shape
- Road laws check
  - Semantic web of road laws
  - City map path check against road laws
- Statistics and analysis
  - Road accident detection

Experiment 1. Road A9, Riga – Liepaja



- In this experiment we covered a part of the road between Riga city and Liepaja city
- This road has one lane for every direction
- Speed limit 90 km/h
- Saturday from 11:00 till 11:30
- Both directions were measured

Experiment 1. Road A9, Riga – Liepaja

- In rural areas with no speed cameras drivers tend to violate the speed limits very much
- Only a few drivers were following the road rule of 90 km/h limit
- Since the road has only one lane for each direction, some drivers were overtaking other cars which also contributed the higher average speed

	Direction	
	Riga – Liepaja	Liepaja – Riga
Cars passed	137	145
Avg travel time, s	750.11	727.27
Distance, m	22 000	22 000
Average speed, km/h	105.6	108.9
Speed limit, km/h	90	90
Violation, km/h	15.6	18.9
Has speed camera	No	No

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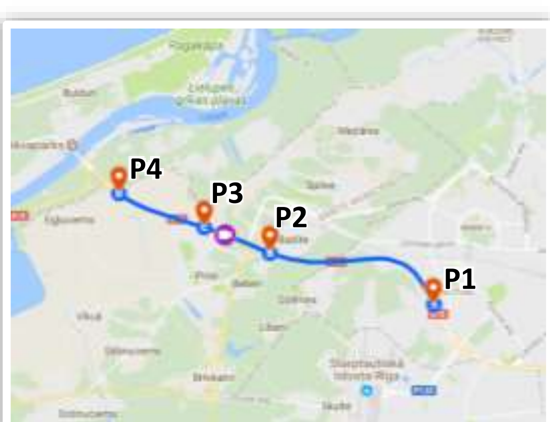
Experiment 2. Karla Ulmana Street



- Road between Riga and Jurmala
- This is the main connection between two cities, which has a 3 lanes on the road for both directions
- The speed limit on this road is 90 km/h.
- In the middle of the road there is a static speed camera installed on a regular basis

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Experiment 2. Karla Ulmana Street

- Drivers do not violate the speed limit in the segment B, however there is quite big difference on other segments
- Regular single point speed cameras have very limited local impact
- Drivers afraid of fines and slow down when they are checked on speed
- *The longer is the speed check distance, the longer drivers would follow the speed limit*
- We make an assumption: proposed system introduction will have the desired effect of reducing the average speed of cars on the roads

	Road segment		
	A	B	C
From – to	P1 – P2	P2 – P3	P3 – P4
Cars passed	922	759	795
Avg travel time, s	149.91	65.56	70.75
Distance, m	4360	1630	2150
Average speed, km/h	104.7	89.5	109.4
Speed limit, km/h	90	90	90
Violation, km/h	14.7	-0.5	19.4
Has speed camera	No	Yes	No

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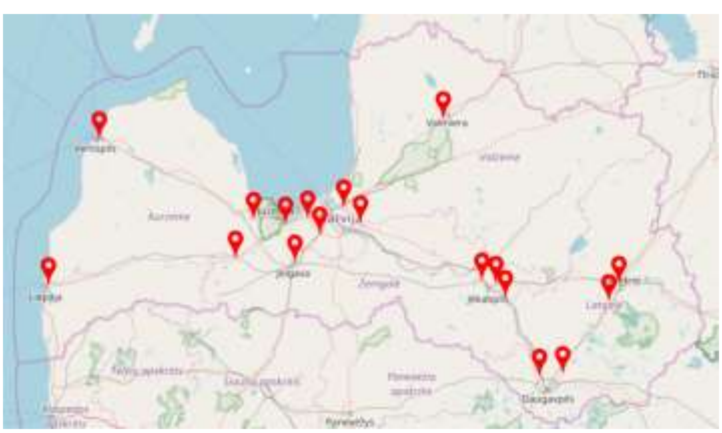
System Introduction – Rural areas



- To cover all the roads between the main cities of Latvia it is required to install road sensor devices in only 18 locations

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System Introduction – Urban Areas

- Riga city is the biggest and the most important city that has to be covered
- To cover all main roads of Riga it is required to install road sensor devices in 18 locations
- Every main road with straight segments between crossings has road sensors – at the beginning of each segment and at the end of the segment

Conclusions

- By this introduction of the proposed system on the roads of Riga and Latvia we estimate the average speed decrease at least by 10-15 km/h in intercity roads.
- According to WHO and Department of Transport of London statistics such change should decrease the road accidents rate by 25% and road fatalities rate by 40% or more.
- With all these changes in rural and urban areas we expect that Latvia significantly improve safety on roads and move from the 1st place to 8th place in the list of countries with most dangerous roads in Europe with estimated no more than 12.0 fatalities per 100 000 motor vehicles.

Thank you

Questions?

Static Speed Cameras – Current Situation

Currently 48 stationary speed cameras are installed in Latvia

Comparison

	Police patrol	Speed radar	SPECS, UK	Tutor, Italy	FasTrack, US	This research
Car identification	yes	yes	yes	yes	yes, device	yes
Speed check	yes, instant	yes, instant	yes, average	yes, average		yes
Traffic light	yes					yes
Direction and turns	yes					yes
Statistics gathering			yes		possible	yes
Accident detection	yes					yes
Toll road payment				yes	yes	possible
Range	local	local	wide	wide	wide	wide

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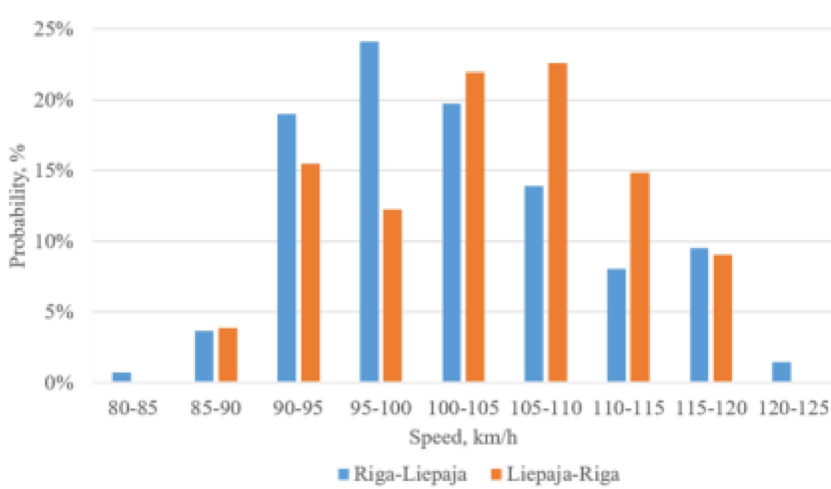
Experiment 1. Speed details



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Summary

- In my PhD I am focused on a research of a Smart City roads environment with distributed road tracking and road traffic controlling system.
- This system has multiple devices installed on city roads equipped with cameras, sensors, and automatic car number recognition module.
- All these devices are interconnected to monitor the road traffic on large areas, recognize and track individual vehicles, determine the amounts of cars in various districts of the city in real-time, detect traffic congestions, and collect various kinds of statistics to smartly control the traffic for a more efficient city transportation.

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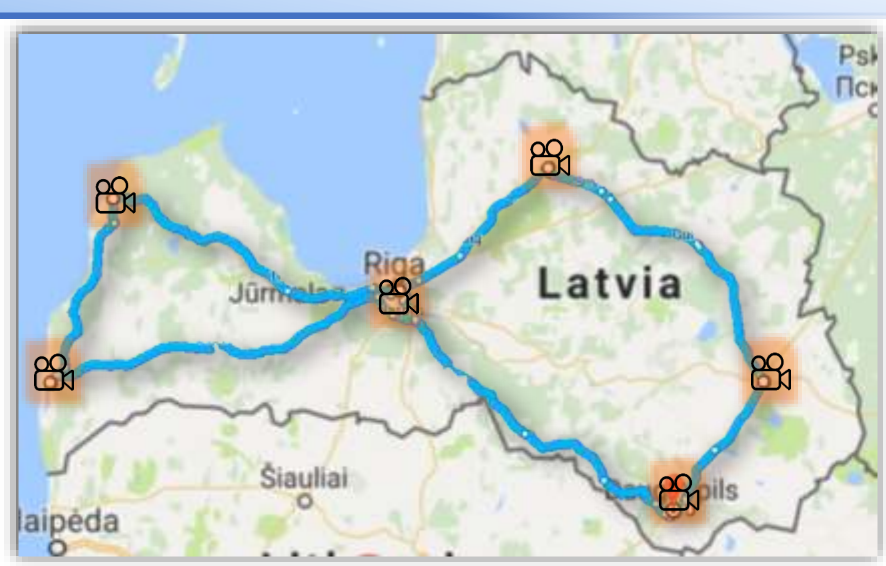
Large Scale Application – Latvia Case



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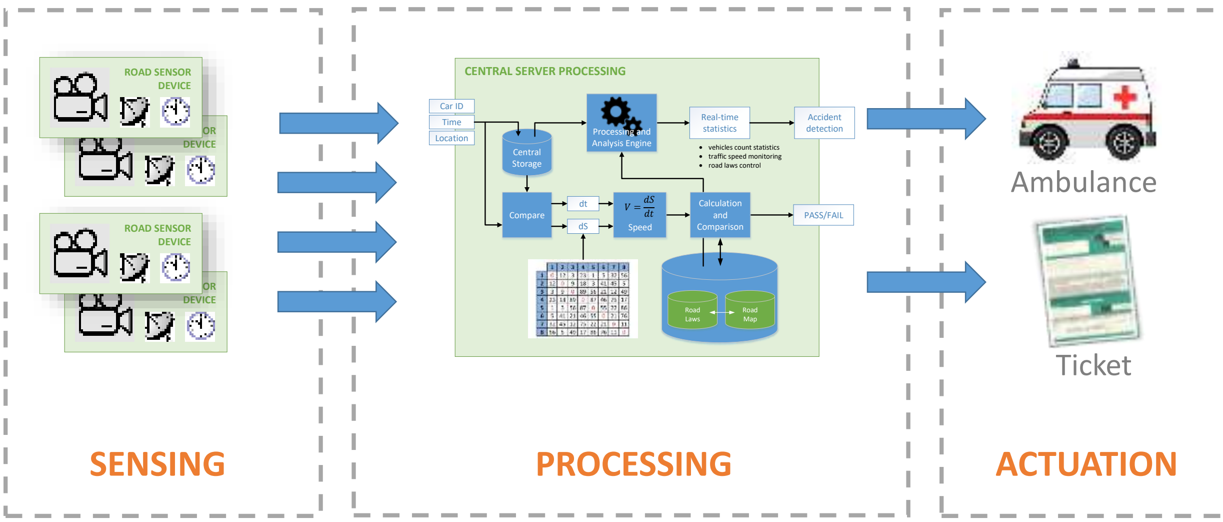
Overall System Design



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Related work

- Instantaneous speed measurement
  - Radar speed guns with microwave Doppler effect
  - Infra-red light sensors
- Average Speed cameras
  - SPECS (Unighted Kingdom)
  - Trajectcontrole (Netherlands)
  - Odcinkowy pomiar prędkości (Poland)
  - Section Control (Austria)
  - Safety Tutor (Italy)
- Automatic parking system

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Significance

- Current research is very important for Latvia because road safety situation in the country is very low. The average road fatality rate in European Union (EU) is equal to 51 dead per million inhabitants whereas road fatality rate in Latvia is **222 dead** per million people. Latvia has the highest road fatality rate among countries of EU.
- In my research I am proposing a distributed road tracking system with road laws enforcement, which makes a significant contribution to road safety on large urban areas, including districts and whole cities. The research achievements are going to be tested and applied on roads of Riga city, capital of Latvia, which has 32% of Latvia population, which will improve road safety for the whole country.

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Effect

- There exists evidence that implementation of systems such as SPECS (United Kingdom) has a considerable effect on the volume of drivers travelling at excessive speeds; on the stretch of road mentioned above (A77 Between Glasgow and Ayr) there has been noted a "huge drop" in speeding violations since the introduction of a SPECS system.

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Road Sensor

Road Sensor with automatic car number plate recognition module is

- All stored images are assigned with a predefined time to live (TTL) which is depended on distances to other nearest road traffic sensor points.
- During a normal operation old images are cyclically overwritten with the new ones to reuse the limited storage space.
- In case of detected speeding violation, which is determined at the central server, specific image can be marked for a longer storage by extending its time-to-live setting and uploading to a server.

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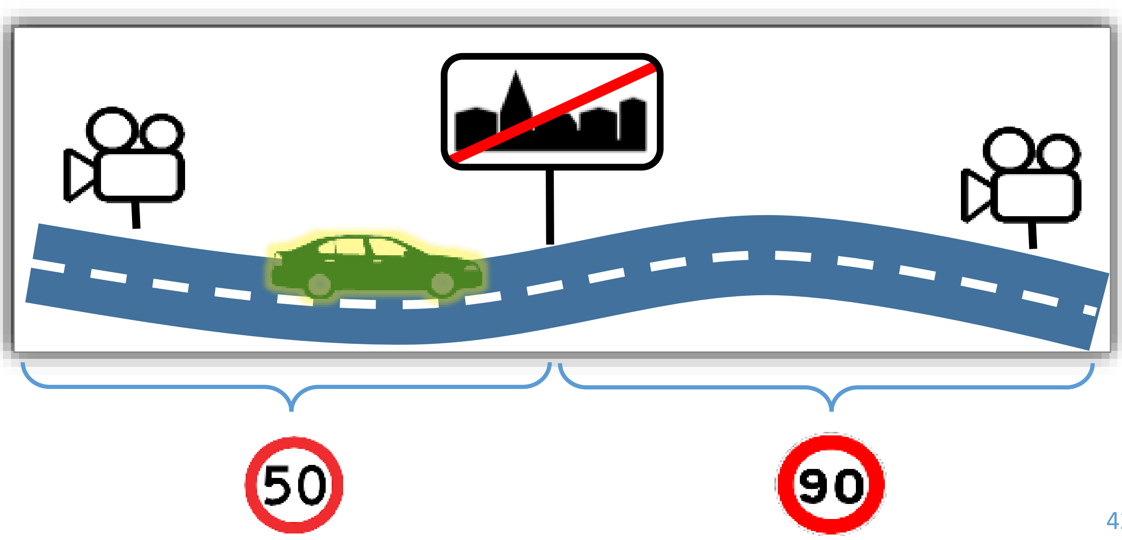
Varying Speed Limits



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Road laws violation notice

- Evidence about the violation
  - Photo pictures
  - Time

Distributed system architecture

- To minimize data transfer size between Road Sensors and Central Server car license number recognition is performed directly in the Road Sensor.
- To keep the system accurate on speed calculation it is crucially important to have the same clock time on every device in the network. Therefore, an important procedure in system operation will be clock synchronization.
- The central server will also have a central storage place where all tracking history is stored. Along with this storage there will be data analysis module.
- The distributed system will have scalable architecture which is capable of interconnecting districts to one city, cities to country regions, and to the whole country level.

Smart City Roads

- The described distributed road tracking system is a prototype of a wide Smart City Roads system for transport registration, road laws enforcement system, and smart traffic flows analysis to advance urban transportation.

- My internship research involves experiments on data collection of a road environment and traffic flow data on the roads of Riga city to estimate real-time road traffic capacity, average traffic speed, individual drivers' speeds, and route source-destination information statistics.

Motor Vehicle Collision

- A **traffic collision**, also called a **motor vehicle collision** (MVC) or many other terms, occurs when a vehicle collides with
  - another vehicle,
  - pedestrian,
  - animal,
  - road debris,
  - other stationary obstruction, such as a tree or pole.
- Traffic collisions often result in
  - injury,
  - death,
  - property damage

Economic costs for society

- The global **economic cost** of motor vehicle collision MVCs was estimated as **$870 billion** per 2010 year.
- which included:
  - lost productivity,
  - medical costs,
  - legal and court costs,
  - emergency service costs (EMS),
  - insurance administration costs,
  - congestion costs,
  - property damage

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Latvia Car Accidents

- Each year in Northern European countries there are about 4 674 traffic collisions, **525 fatalities** and 3 925 injured.
- Latvia has the highest fatality rate in the European Union with **222** people killed per million inhabitants.
- According to the US State Department:

  "Latvia has one of the highest rates of automobile accidents and fatalities in Europe." However crashes have been decreasing in recent years, but violation of traffic rules is still common, high risk passing is often the rule, even in crowded urban areas. Additionally some Latvian drivers fail to yield to pedestrians.

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Data retrieval

Basic data retrieval features include following items:

- Passed vehicles count statistics per hours, days, weeks, months, seasons, and years, as well as by location: road, district, city, country
- Speed monitoring statistics for individual vehicles and for overall traffic capacity on different levels (road, district, etc.)
- Speed regulation for road laws enforcement including automatic generation and sending fine sheets to recognized vehicles owners.

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ANALYSIS OF RIGA INTERNATIONAL AIRPORT FLIGHT DELAYS

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TRANSPORTA UN SAKARU INSTITŪTS

UNIVERSITY of THESSALY

Traffic, Transportation and Logistics Laboratory

Fraunhofer IFF

www.alliance-project.eu

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Young Researchers' Seminar: "Sustainable Transport Interchanges"
20-21 October 2017, Riga, Latvia

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Worldwide flight delay

Year	Ontime Arrivals	Ontime (%)	Arrival Delays	Delayed (%)	Flights Cancelled	Cancelled (%)	Diverted	Flight Operations
2008	2,213,622	73.90%	704,709	23.53%	70,671	2.36%	6,508	2,995,510
2009	2,116,172	79.47%	497,520	18.68%	42,970	1.61%	6,134	2,662,796
2010	2,096,035	79.81%	466,350	17.76%	57,717	2.20%	6,316	2,626,418
2011	1,918,094	76.59%	511,002	20.41%	68,901	2.75%	6,242	2,504,239
2012	2,104,374	84.30%	360,463	14.44%	26,615	1.07%	4,776	2,496,228
2013	2,077,611	79.40%	490,102	18.73%	43,520	1.66%	5,379	2,616,612
2014	1,783,676	74.66%	519,682	21.75%	79,494	3.33%	6,234	2,389,086
2015	1,867,232	78.27%	458,474	19.22%	53,715	2.25%	6,194	2,385,615
2016	1,897,646	82.87%	357,236	15.60%	29,839	1.30%	5,105	2,289,826
2017	1,824,076	79.17%	439,424	19.07%	35,162	1.53%	5,281	2,303,943

2

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Analysis of the airport flight delays at the European countries

- The analysis at the European airport delays shows that:
  - 80% of delays on flight arrival could be forecast from the delay on departure
  - The airline which flight destination has been studied allows a very small margin between the scheduled and the real flight and taxiing times, which does not allow absorption of any part of departure delays
  - There is some evidence that the scheduled stop time plays an important role in absorbing the arrival delays. For instance, a 45-minute scheduled stop time does not allow a delay recovery, if the departure plane is 80% loaded.
  - 70% of delays on departure, could be forecast from the departure plane load factor, when the plane is not significantly delayed on arrival

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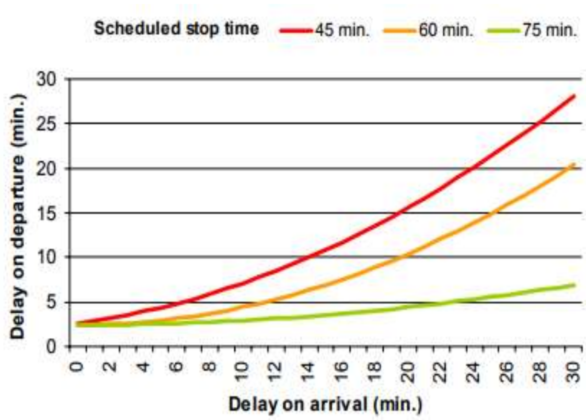
Relation between Departure delay and the delay on arrival



The shorter the station stop time, the greater the sensitivity of the delay on departure to the delay on arrival

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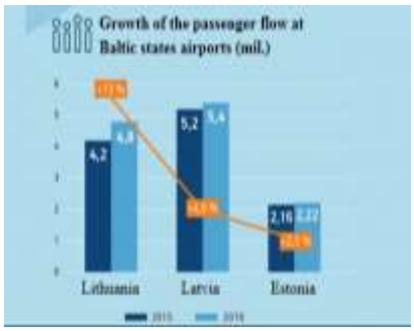
Aviation sector in Baltic states



Distribution of passengers at airports in the Baltic States in 2016

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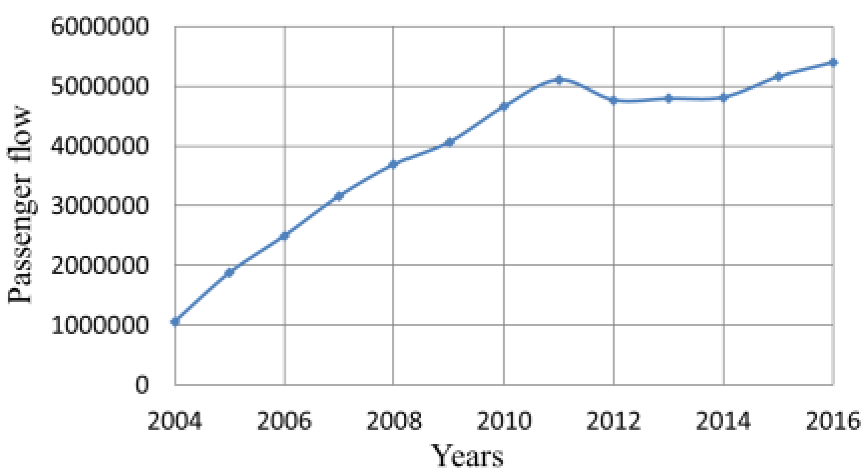
Passenger flow growth in Latvia



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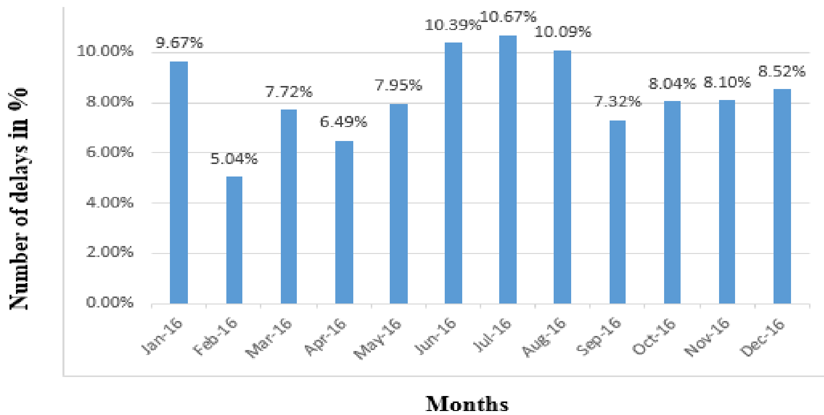
Analysis of Aircraft Flight delays at Riga International Airport



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Characteristic of main flight delays groups

No	Problems group	Numbers of delay	Time of delay total (min)	Average of delay(min)	Delay in %
Group A: characteristic of main flight delays related to airport procedure					
1	Ground handling	1188	16510	15	25%
2	Plan maintenance	676	36175	54	59%
3	Automated equipment failure	209	3055	15	5%
4	Crew problems	472	5485	12	9%
5	Other	140	1424	10	2%
Total of the group A		2685	62649	23	33%
Group B: characteristic of main flight delays related to other procedures					
6	Weather	468	7886	17	4%
7	Air traffic flow management	975	18672	19	10%
8	Aircraft problems	4851	93021	19	48%
9	Airline problems	272	11182	41	6%
Total of the group B		6566	130761	20	67%
TOTAL of groups A+B		9251	193410	21	

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Characteristic of main flight delays groups

No	Problems group	Numbers of delay	Time of delay total (h)	Time of delay total (min)	Average of delay (min)
A	Check-in error	676	133,78	8027	12
B	Baggage processing	2	0,23	14	7
C	Cargo	83	21,15	1269	25
D	Loading/unloading	507	129,27	7756	15
E	Servicing equipment	36	4,83	290	8
F	Aircraft cleaning	18	2,62	157	9
G	Fuelling/defueling	17	4,17	250	15
H	Catering	13	2,15	129	10
I	Operation requirements	74	8,25	495	7
TOTAL		1426	306,45	18387	13

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Characteristic of flight delays by cause of ground handling movement at the aerodrome

- Maximum duration of flight delays is 15 minutes, total duration of flight delays by this reason is 130 hours or 85% of delays in this certain group
- As we can see from above presented data, one of the main factors that play a key role in increasing the efficiency of airport operations is reducing the downtime of the aircrafts on the ground by reasons related to ground handling services
- In order to deal with the delays related to ground handling movement at the aerodrome at Riga International Airport, a simulation model will be developed for fragment of Riga International Airport, where we plan to test and simulate the operation of above mentioned airport

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Conclusions

- The influence of o ground handling vehicles movement at the aerodrome on aircraft flight delays was observed
- The analysis of flight delays data for Riga International Airport demonstrates that the number of flight delays increases by approximately 30% during high seasons.
- By analysing the reasons of flight delays, we note that these reasons are divided into two main groups:
  - One group is related to services which are not directly related to airport operation procedure. This group was not studied during this research as far as it is not the subject of our research
  - The other group is tightly related to airport services. Analysing the second group the relation between flight delays and various aspects of airport services was observed
- Analysis shows that there is a considerable impact of ground handling services on the flight delays

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Thank you for your kind attention

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Modelling and Simulation of RIX to reduce turnaround times of crucial clearance processes

Alina Bianca Rettmann

David Weigert
Iyad Alomar
Juri Tolujew

Riga, 20.10.2017

This project has received funding from the *European Union's Horizon 2020 research and innovation programme* under grant agreement No 692426

Contents

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Motivation

- Aeroplanes create only revenue while flying
- Punctuality of aeroplanes is important[2]
  - To keep flight schedule intact
- More passengers expected
  - Worldwide number of passengers will nearly double between 2016 and 2035[1]

3

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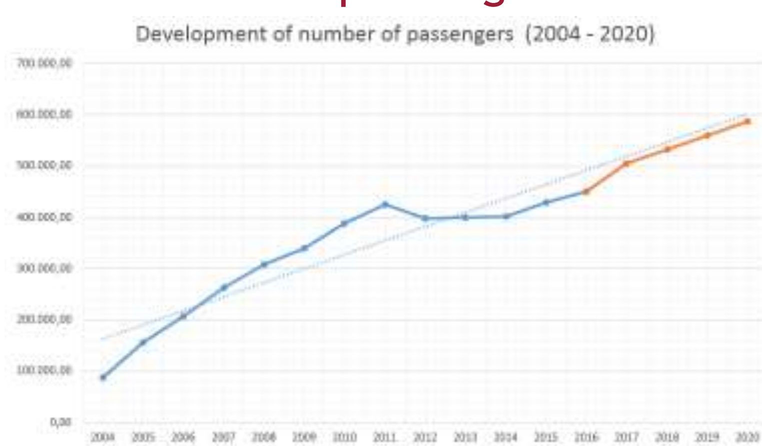
RIX – Number of passengers



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RIX – Number of flights

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Problem formulation

- Hypothesis:

  Prioritisation of certain ground vehicles improves turnaround time of aeroplanes at an apron of an airport

- Allocation problem (parking position) for aeroplanes
  - Parking position of the aeroplane
- Routing algorithm for ground vehicles
  - Routing algorithm for the ground vehicles
- Way of prioritisation for ground vehicles
  - Constraints for prioritisation

Key figures and goals

- Key figures
  - Non-operation period of an aeroplane
    (also: handling time of an aeroplane)
  - Estimated and actual time of travel for ground vehicles
  - Distance
  - Utilisations of resources

- Objective
  - Improve driving times of ground vehicles
  - Find indicators which kind of prioritisation to use under which constraints

RIX - Location

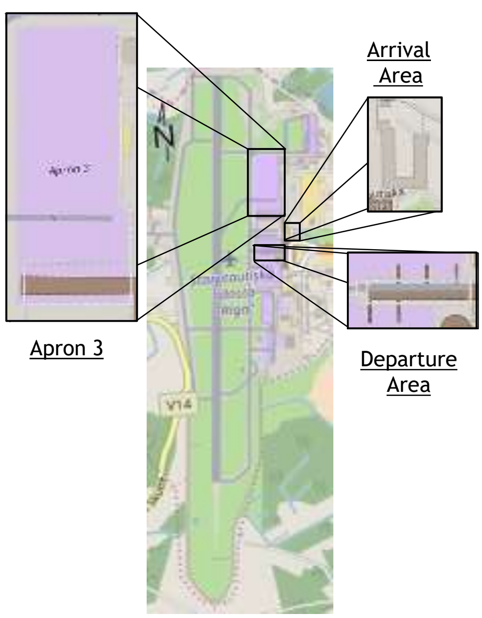
- 5.4 nautical miles (approx. 10 kilometres) west of Riga
- Built in 1974, modernised between 1993 and 2001
- State owned by the Republic of Latvia
- Over 75 destinations in summer and 60 destinations in winter

According to: http://www.openstreetmap.org/#map

RIX - Layout

According to: http://www.openstreetmap.org/#map

RIX - Layout



According to: http://www.openstreetmap.org/#map

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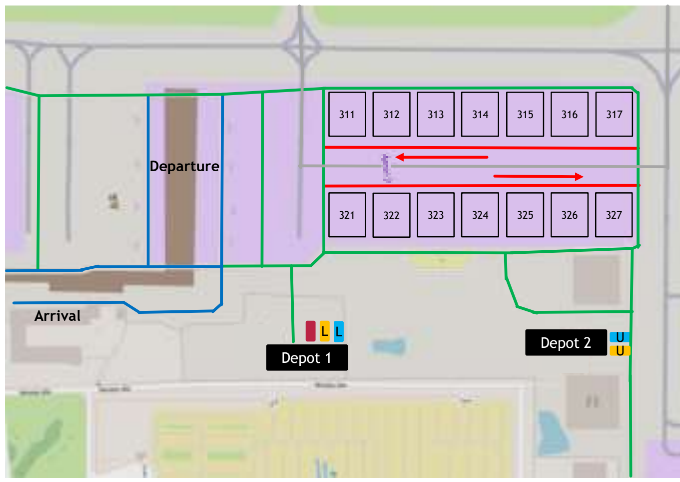
Layout of conceptual model

Caption:

U Unloading
L Loading
Passenger Bus
Tug and Dolly for Baggage
Fuel Truck

Path for vehicles:
One-way, 30 km/h
Both-way, 15 km/h
Both-way, 30 km/h
Aeroplanes, 30 km/h



According to: http://www.openstreetmap.org/#map

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Process Chain model

Drive to stand
- Aeroplane drives to stand
- Ground vehicles drive to stand

Unloading aeroplane
- Passengers deplane
- Unload baggage

Fuelling aeroplane
- Bring to Arrival Area
- Get from Departure Area
- Fuel aeroplane

Loading aeroplane
- Passengers enplane
- Load baggage

Allowance for takeoff
- Aeroplane drives to taxiway

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Drive to stand

Caption:

U Unloading

L Loading

Passenger Bus

Tug and Dolly for Baggage

Fuel Truck

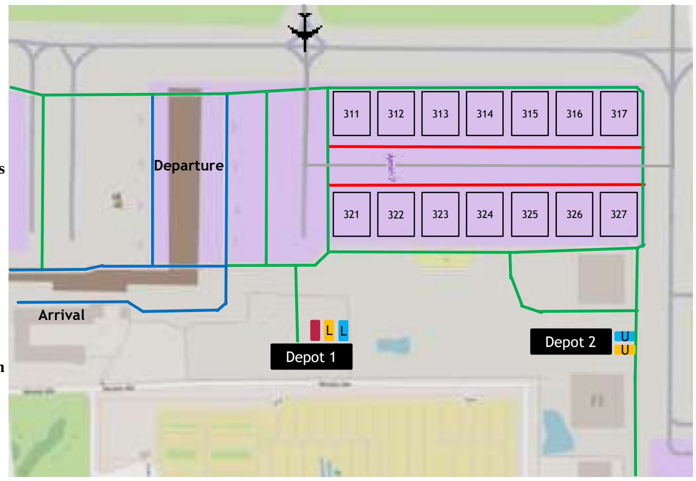
Path for vehicles:

One-way, 30 km/h

Both-way, 15 km/h

Both-way, 30 km/h

Aeroplanes, 30 km/h



According to: http://www.openstreetmap.org/#map

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Unloading

Caption:

U Unloading

L Loading

Passenger Bus

Tug and Dolly for Baggage

Fuel Truck

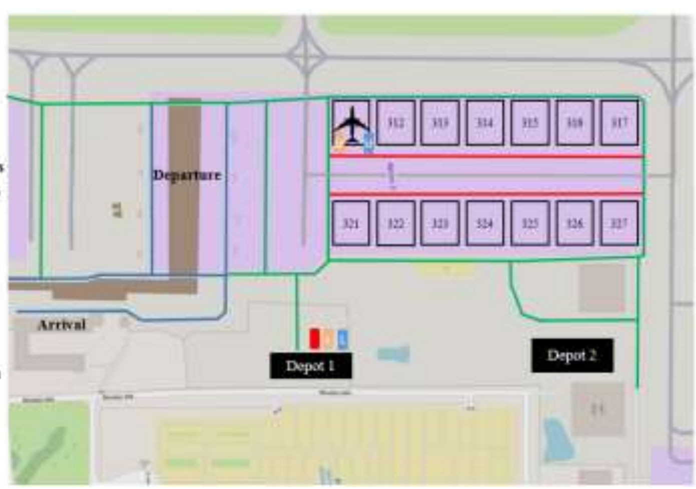
Path for vehicles:

One-way, 30 km/h

Both-way, 15 km/h

Both-way, 30 km/h

Aeroplanes, 30 km/h



According to: http://www.openstreetmap.org/#map

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Fuelling

Caption:

U Unloading

L Loading

Passenger Bus

Tug and Dolly for Baggage

Fuel Truck

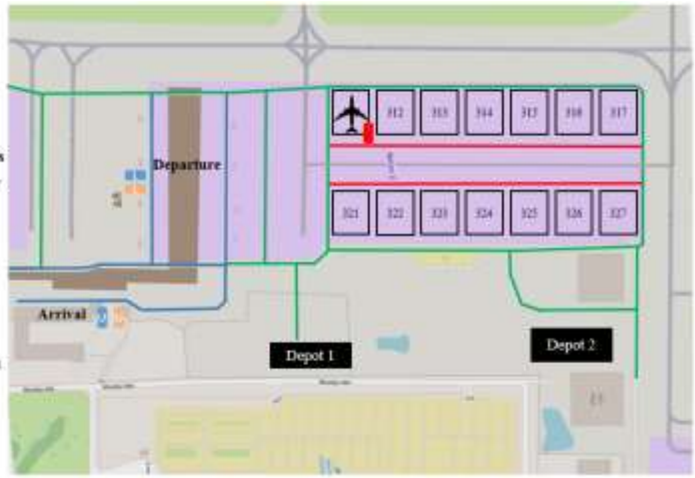
Path for vehicles:

One-way, 30 km/h

Both-way, 15 km/h

Both-way, 30 km/h

Aeroplanes, 30 km/h



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Loading

Caption:

U Unloading

L Loading

Passenger Bus

Tug and Dolly for Baggage

Fuel Truck

Path for vehicles:

One-way, 30 km/h

Both-way, 15 km/h

Both-way, 30 km/h

Aeroplanes, 30 km/h

According to: http://www.openstreetmap.org/#map

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Drive to taxiway

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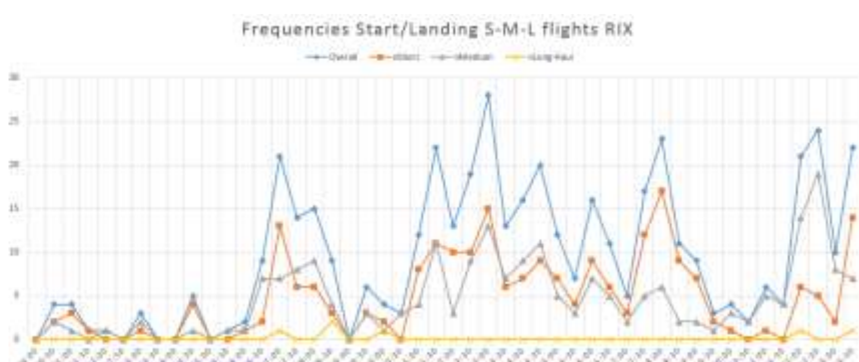
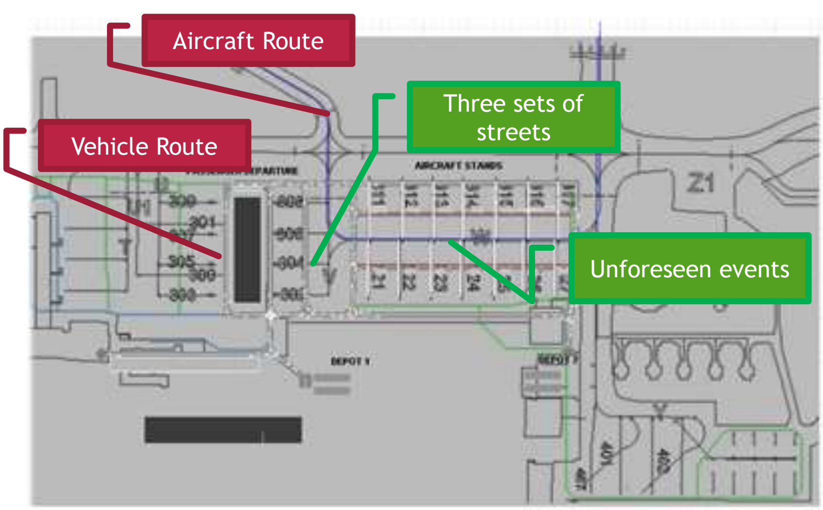
Data Preparation & Rough calculation



Rough calculation

	Short-haul airplane		Medium-haul airplane		Long-haul airplane	
	314	**324**	**314**	**324**	**314**	**324**
Drive to stand and wait	1,36	0,95	1,36	0,95	1,36	0,95
unload baggage and passengers deplane	6,17		13,32		21,04	
Fuelling	8,85	9,53	15,68	16,68	23,4	24,4
Load aeroplane and passengers enplane	5,43		10,36		15,61	
departure	0,86		0,86		0,86	
Total (in industrial minutes)	22,67	22,94	41,58	42,17	62,27	62,86

Conclusion



Outlook

- Formalised model
- Plan scenarios
- Analyse gained data for future projects

Thank you for your time!

References

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TRANSPORT AND TELECOMMUNICATION INSTITUTE

DETERMINATION OF PARAMETERS FOR FORMING RIGHT ALLOCATION OF ITEMS IN PICKING AREA

Transport and Telecommunication institute
Transport and Logistics faculty
Transport and Logistics department

Mg. oec, lecturer, Raitis Apsalons

Asoc.prof.sc.ing. Gennady Gromov

LATVIA

Current events of topic

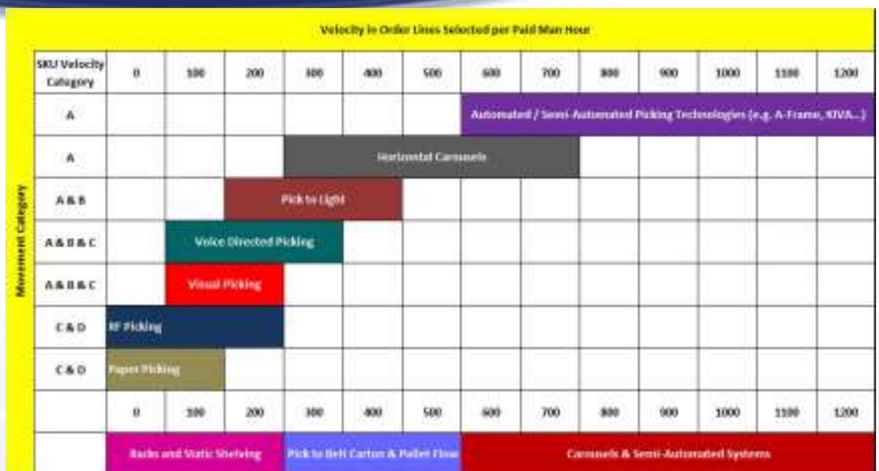
Right planning, organizing and controlling of picking process becomes vitally important.

The key indicator for choose of any picking technology in the warehouse appears velocity of order lines picked per paid man hour.

If number of order lines picked per paid man hour is relatively small, usually primitive picking technologies are used.

2

Current events of topic



http://www.mwpvl.com/html/order_pick_technologies.html

3

Current events of topic

Practical problem: Collecting of customer orders very often are not realised in efficient way – warehousing companies <u>do not consider the right allocation of items in the picking route</u>

Scientific problem: is to approve that parameters for forming right allocation sequence of items into picking addresses can diminish total picking travel distance.

4

The aim of topic

The main purpose is to determine one general parameter or more parameters for forming right allocation sequence of items for replacement picking addresses corresponding by picking route.

5

The object and subject of the research

The object of the research concerns the picking process.

The subject of the research - is allocation sequence of items into picking addresses.

6

Restrictions of the research

1) One row rack storing system available in the warehouse.
2) Each item is placed on separate pallet. Let it be physical picking system: pick and walk (Tomkins, 2003). For this purpose picking area (PA) is established in this warehouse.
3) Picking process will be realized by picking handling units (HU) and customer units (CU). Therefore ground level and first level of pallet racks are used as PA. The one picking location of each item consists of 2 pallets: 1 pallet on ground level and second one on the first level of rack.

7

Restrictions of the research

4) It is defined that replenishment – moving the item from storing area (SA) to PA - will occur if stock of definite item in picking location will achieve critical level. This approach is called as Red Card principle (RCP) of picking system.

8

The principle of dividing of orders

The principle of dividing of orders (PDO) states that quantities for definite SKU of each order are divided into 2 parts:

- For picking full pallets (FPLL) from SA – for single order usually expressed in customer units from SA.
- For picking handling units (HU) and customer units (CU) from PA – for single order usually expressed in customer units from PA.

9

Several variants of allocation of zones

Variant 1: Picking from the single area – only the storing area (SA) exists in the warehouse, in picking process for reaching highest levels of racks either pallet forklifts are used for extracting FPLL, and high level order pickers (HLOP) are used for extracting HU and CU.

Variant 2: Picking from two separate zones, additionally using PDO, from SA are collected FPLL, but from PA - HU and CU.

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Several variants of allocation of zones

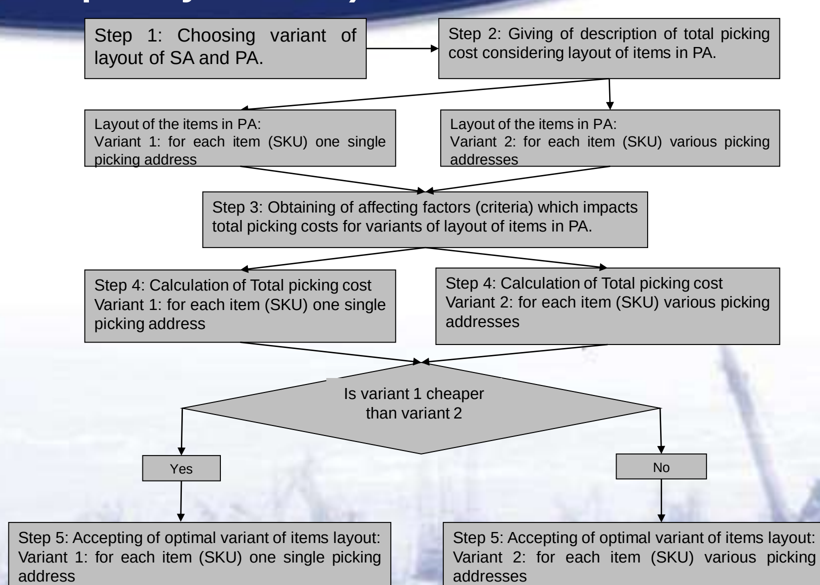
Variant 3: Picking from two separate zones, but PA is allocated in SA, additionally using PDO, from SA are collected FPLL (second and higher levels of pallet racks are used), but from PA - HU and CU (the first two levels of pallet racks are used).

Variant 4: Picking from three separate zones, additionally using PDO, from SA are collected FPLL, from the first PA (PA1) - HU and from the second PA (PA2) are picked CU.

Variant 5: Automated picking systems, for example the AS/RS – Automated Storage and Retrieval System, expressed as the G2M – goods to man picking system.

11

The methodology of evaluation of total picking cost (developed by authors)



12

Several picking methods for “pick and walk” approach

1) S - shape method
2) largest gap method
3) return method
4) midpoint method
5) combined method of previous.

Finally evaluation of optimal picking method should be done.

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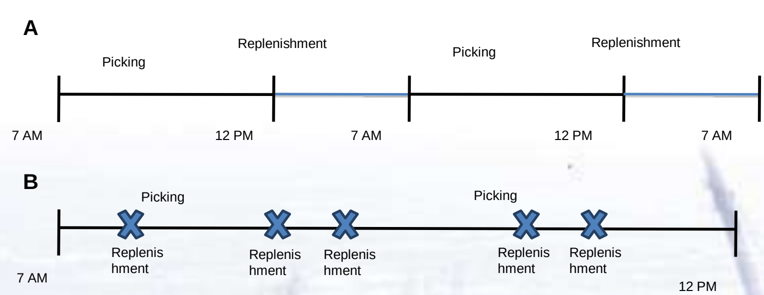
Approaches of the layout of items in PA

A) various picking locations for each single SKU

B) B) one single picking location for each single SKU



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Proposed parameters for forming right allocation sequence of SKU

Authors have proposed parameters for forming right allocation sequence of SKU into picking addresses corresponding by picking route.

The parameter 1: the number of orders for each SKU.

The parameter 2: the average volume of each SKU per picked order.

The parameter 3: the total revenue of each SKU per quarter (forming of quarters depends on seasonal aspect): group A: 80% of total revenue; group B: 15% of total revenue and group C: 5% of total revenue.

15

Proposed parameters for forming right allocation sequence of SKU

The parameter 4: the group of brands of SKU.

The parameter 5: the key accounts of consumers.

The parameter 6: the key accounts of suppliers.

The parameter 7: the average turnover of each SKU in a day.

The parameter 8: the size of each SKU.

The parameter 9: the gross weight of HU or CU.

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Example of right allocation of SKU by number of orders

Optimisation criteria for right allocation of SKU in the picking addresses in PA is the total travel distance made by picker (warehouse worker) in a day.

If picking demand fluctuates in different days of a week then the total travel distance of picker can be measured per month or by seasonal changes – in a quarter.

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Example of right allocation of SKU by number of orders

Description of the example:

1) The warehouse has PA which consists of pallet locations as zone included into SA.
2) The 3-rd variant of organizing orders' picking process in the warehouse is chosen.
3) In order to simplify process, we are going to assume that M2G picking system is used.
4) Single order is picked by single picker.
5) Additional assumption that picker has to collect 7 orders.
6) Each order contains different SKU's in picking list.
7) Picking zone for this picker consists of following aisles and racks: aisle 01: racks A and B; aisle 02: racks C and D; aisle 03: racks E and F; aisle 04: racks G and H.

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Total travel distance (L_1) before right SKU allocation in picking addresses

Location	SKU	Order_1	Order_2	Order_3	Order_4	Order_5	Order_6	Order_7	Total, HU
A-03	SKU_01	0	0	4	9	12	10	0	**35**
B-05	SKU_02	1	0	0	0	0	5	0	**6**
A-17	SKU_03	4	4	0	0	0	0	0	**8**
B-34	SKU_04	7	5	12	7	8	0	12	**51**
C-48	SKU_05	3	5	7	3	0	0	5	**23**
D-23	SKU_06	0	0	0	1	2	0	0	**3**
D-02	SKU_07	5	7	13	0	0	9	7	**41**
E-08	SKU_08	0	3	15	8	6	14	5	**51**
F-13	SKU_09	4	5	7	8	2	2	0	**28**
F-33	SKU_10	5	0	6	0	4	0	3	**18**
E-42	SKU_11	0	3	0	8	8	0	2	**21**
E-66	SKU_12	10	4	14	0	0	16	0	**44**
G-55	SKU_13	8	7	4	2	0	0	1	**22**
H-52	SKU_14	0	0	0	4	0	2	0	**6**
G-21	SKU_15	8	0	0	0	3	1	1	**13**
G-11	SKU_16	5	0	0	0	0	4	1	**10**
G-04	SKU_17	0	1	4	5	0	0	1	**11**
H-01	SKU_18	8	3	12	3	2	4	14	**46**
L_1, meters		267	267	267	267	267	267	267	**1869**

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Determination of allocation parameter

Total picked HU is no parameter for right allocation of SKU's.

Authors prefer to use parameter for optimizing total travel distance of single picker. The parameter is: the number of orders for each SKU.

In other situations other parameters are usable.

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Total travel distance (L_2) after right SKU allocation in picking addresses

Location	SKU	Order _1	Order_2	Order_3	Order_4	Order_5	Order_6	Order_7	**O_num**
A-03	SKU_18	8	3	12	3	2	4	14	**7**
B-05	SKU_04	7	5	12	7	8	0	12	**6**
A-17	SKU_08	0	3	15	8	6	14	5	**6**
B-34	SKU_09	4	5	7	8	2	2	0	**6**
A-44	SKU_05	3	5	7	3	0	0	5	**5**
B-46	SKU_07	5	7	13	0	0	9	7	**5**
B-52	SKU_13	8	7	4	2	0	0	1	**5**
A-53	SKU_01	0	0	4	9	12	10	0	**4**
A-65	SKU_10	5	0	6	0	4	0	3	**4**
B-65	SKU_11	0	3	0	8	8	0	2	**4**
C-64	SKU_12	10	4	14	0	0	16	0	**4**
D-64	SKU_15	8	0	0	0	3	1	1	**4**
D-43	SKU_17	0	1	4	5	0	0	1	**4**
C-39	SKU_16	5	0	0	0	0	4	1	**3**
C-37	SKU_02	1	0	0	0	0	5	0	**2**
D-12	SKU_03	4	4	0	0	0	0	0	**2**
D-09	SKU_06	0	0	0	1	2	0	0	**2**
C-01	SKU_14	0	0	0	4	0	2	0	**2**
L_2, meters		131	131	131	131	131	131	131	**917**

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Conclusion

In order to get right sequence of allocation of these items at first we need to sort all SKU's by the number of orders.

Then first address in the picking route will be engaged by the SKU with the biggest number of orders, but in the end of picking row we will find SKU which is less popular in all orders.

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Conclusion

As result we receive new allocation sequence for all SKU's which take participation in picking process.

After right SKU allocation in picking addresses (see column Location in table 2), the total travel distance (L2) for this picker equals 917 meters.

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Conclusion

A choice of appropriate parameters and forming logical algorithm is unequivocally.

It depends on picking systems, storing systems, from the speed of the turnover of each SKU, etc.

Therefore initially stage is logistics audit of definite warehouse. The results of each warehouse could be different.

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Conclusion

There are some serious questions which will be as guidelines for building right allocation sequence of items into picking addresses corresponding by picking route:

- What is level of similarity of SKU?
- Are items intended or ordered by few clients or delivery points?
- What kind of warehouse systems and racks will be planned in PA?
- What is the impact of size, weight and volume of each SKU?
- What is capacity of picking cars used in picking process?
- What is the impact of turnover of each SKU?

Thank you for attention!

Smart solutions for 3PL operators: state-of-the-art

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Outline

- Actuality of the research
- 3PL operator essence
- Technology analysis
- Case-study 1
- Case-study 2
- Conclusions

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Actuality

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Key definitions

- 3PL operator

Third Party Logistics (3PL) is the function by which the owner of goods (The Client Company) outsources various elements of the supply chain to one 3PL company that can perform the management function of the clients inbound freight, customs, warehousing, order fulfilment, distribution, and outbound freight to the clients customers.

Bridgefield Group

- Smart logistics

The technology driven approach that is used to define Smart Products and Smart Services is utilized and extended to define "Smart Logistics".

Uckelmann, D. (2008): A Definition Approach to Smart Logistics.

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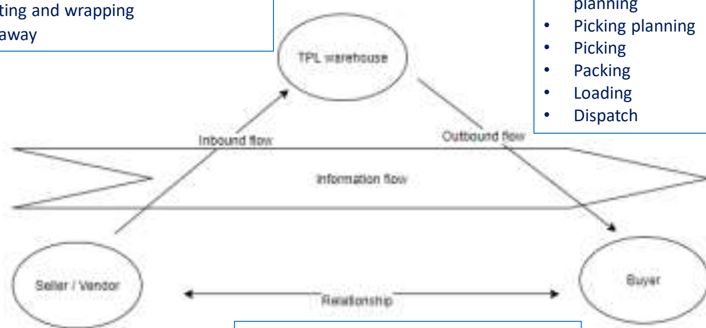
Role of 3PL operator

Inbound flow normally includes operations like:

- Unloading – manual or mechanized
- Sorting and wrapping
- Putaway

Outbound normally includes operations like:

- Order receive, order consolidation and routes planning
- Picking planning
- Picking
- Packing
- Loading
- Dispatch



3PL's internal flows:

- Replenishment process
- Expiration and damage control process
- Slotting
- Counting and cycle count

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3PL operator challenges

- Minimizing lead time between deliveries
- Ensuring they have the latest IT and automation systems to allow better tracking of materials and products through each stage of the process
- Flexibility- A flexible third part logistics company will be well equipped to handle different types of products and materials as well as technological changes that could impact the industry
- A motivated workforce. This can make a huge difference to a 3PL company as it will mean their customers will get a higher quality service

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The main questions should be answered:

- What technologies are most suitable to various 3PL processes and supply chain management?
- What are the technology readiness level for 3PL processes?

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Technology use matrix in warehousing operations

	IoT / RFID	Big Data/AI	Drones, Robots..	EDI Communications	PDA/Tablets	BarCodes / Optical recognition	Augmented reality
Inbound	X	X		X	X	X	X
Sorting		X	X		X	X	X
Warehousing		X			X	X	X
Slotting		X			X	X	
Inventory management/ Counting		X	X				X
Outbound	X	X		X	X	X	X
Distribution	X	X		X	X	X	

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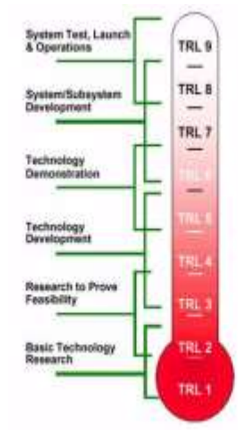
Technology readiness level

Technology readiness level	Description
1. Basic principles observed and reported	Lowest level of technology readiness. Scientific research begins to be translated into applied research and development (R&D). Examples might include paper studies of a technology's basic properties.
2. Technology concept and/or application formulated	Invention begins. Once basic principles are observed, practical applications can be invented. Applications are speculative, and there may be no proof or detailed analysis to support the assumptions. Examples are limited to analytic studies.
3. Analytical and experimental critical function and/or characteristic proof of concept	Active R&D is initiated. This includes analytical studies and laboratory studies to physically validate the analytical predictions of separate elements of the technology. Examples include components that are not yet integrated or representative.
4. Component and/or breadboard validation in laboratory environment	Basic technological components are integrated to establish that they will work together. This is relatively "low fidelity" compared with the eventual system. Examples include integration of "ad hoc" hardware in the laboratory.
5. Component and/or breadboard validation in relevant environment	Fidelity of breadboard technology increases significantly. The basic technological components are integrated with reasonably realistic supporting elements so they can be tested in a simulated environment. Examples include "high-fidelity" laboratory integration of components.



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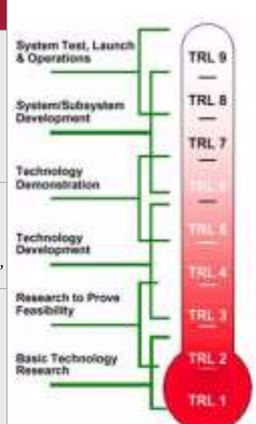
Technology readiness level

Technology readiness level	Description
6. System/subsystem model or prototype demonstration in a relevant environment	Representative model or prototype system, which is well beyond that of TRL 5, is tested in a relevant environment. Represents a major step up in a technology's demonstrated readiness. Examples include testing a prototype in a high-fidelity laboratory environment or in a simulated operational environment.
7. System prototype demonstration in an operational environment.	Prototype near or at planned operational system. Represents a major step up from TRL 6 by requiring demonstration of an actual system prototype in an operational environment (e.g., in an aircraft, in a vehicle, or in space).
8. Actual system completed and qualified through test and demonstration.	Technology has been proven to work in its final form and under expected conditions. In almost all cases, this TRL represents the end of true system development. Examples include developmental test and evaluation (DT&E) of the system in its intended weapon system to determine if it meets design specifications.
9. Actual system proven through successful mission operations.	Actual application of the technology in its final form and under mission conditions, such as those encountered in operational test and evaluation (OT&E). Examples include using the system under operational mission conditions.



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IoT sensors & devices:

- Essence of the technology

The **Internet of Things** (IoT) is a system of physical objects that can be discovered, monitored, controlled or interacted with by electronic devices which communicate over various networking interfaces, and eventually can be connected to the wider Internet

- Benefits

IoT enables warehouse managers to monitor all assets in **real time**. Managers can be alerted when an asset is being over-utilized or when an idle asset should be deployed to do other tasks.

- Limitations

Integration of devices from various manufacturers into a single application or system

It is costly - Connecting everything with the internet and with each other isn't easy, it requires resources, including money, lots and lots of it.

- TRL

For IoT sensors and devices proposed TRL level 8. Which means - Actual system completed and qualified through test and demonstration. There are now various solutions for logistics that are final and used in production enviroments. As business case can be presented ABB case with inbound using RFID devices

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Big Data and AI:

- Essence of the technology

Big data allows automated systems to function through intelligently routing many different data sets and data streams. For example, Amazon already has automation present in their fulfillment centers, which use little orange KIVA robots to grab items from shelves.

Artificial Intelligence: the use of robots and AI in logistics. The Roland Berger Global Strategy Consulting has recently published a study dedicated to the use of robots in logistics, which came to the conclusion that a robot will come to cost half of the cost of a human worker, by 2020.

- Benefits

There is huge untapped potential for improving operational efficiency and customer experience, and creating useful new business models. Consider, for example, the benefits of integrating supply chain data streams from multiple logistics providers; this could eliminate current market fragmentation, enabling powerful new collaboration and services. Many providers realize that Big Data is a game changing trend for the logistics industry.

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Big Data and AI:

- **Limitations**

  Data Is Not Easily Accessible Or Transferable

- **TRL**

  For Big Data and AI technologies proposed TRL level 7. Which means - Prototype near or at planned operational system.

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Drones, Robots:

- **Essence of the technology**

  Drones and robots have been incorporated into yard and warehouse management systems with UAVs being used to perform asset tracking, location monitoring and cycle counting tasks. Drones can automate stock tracking and easily locate and transport inventory from anywhere in the warehouse. These machines could be used to inspect and review cargo at shipping yards and automatically update the data into a transport management system

- **Benefits**

  Less labour costs

  Better quality comparable to human

- **Limitations**

  High implementation costs

  Need high proffesional maintenance stuff

  Technology limitations – battery life etc …

- **TRL**

  TRL level for drones technology used in logistics could be 7. There are some projects and prototypes to use it in stock level inventories, sorting of the goods and picking. But these projects not yet on full production use level.

EDI communication:

- **Essence of the technology**

  Electronic Data Interchange (EDI) is the computer-to-computer exchange of business documents in a standard electronic format between business partners.

- **Benefits**

  EDI is a flexible way to integrate 3PL and client systems.

  It can support information flow for inbound, outbound, inventory adjustment, master data and many other data interfaces.

  EDI is can be fast implemented

- **Limitations**

  Information can be shared between two partners only

  Data integrity should be controlled

- **TRL**

  TRL level for EDI technology should be 9. Technology exists already for years and implemented in different models and businesses.

PDA/Tablets

- **Essence of the technology**

  PDA and handheld devices nowadays used in almost all warehousing operations. Whether receiving, managing or moving products & materials within the warehouse or production unit, or out on the road making deliveries to the customers, handheld devices allows you to take advantage of the latest benefits of using mobile computing technology and improve business efficiency.

- **Benefits**

  No need for paperwork

  All transactions can be seen online or as soon as PDA downloads data

- **Limitations**

  To get data from PDA online, territory should be covered by WiFi

- **TRL**

  TRL level for PDA/Tablets technology should be 9. Technology exists already for years and implemented in different models and businesses.

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BarCodes/Optical recognition:

- **Essence of the technology**

  Different types of barcodes widely used in logistics as its processes requires precise timing, tracking and consistency. Barcode scanning allows companies to identify goods and its current position in the supply chain.

- **Benefits**

  Product tracking

  Goods identification

- **Limitations**

  Limits of data can be encoded

  BarCode printed on the parper or packing so can be damaged and become unreadable

- **TRL**

  TRL level for PDA/Tablets technology should be 8. Technology exists already for years and implemented in different models and businesses. Now when AI and BigData technologies grows really fast optical recognition technology togather with AI could have new or better use models.

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Augmented reality:

- **Essence of the technology**

  Augmented Reality (AR) – where every object you see could be enriched with additional and valuable information. AR is defined as the expansion of physical reality by adding layers of computer-generated information to the real environment.*

- **Benefits**

  Easy, fast, ontime access to information

  New options for controlling real-world objects through digital means. This allows a mixed reality where real objects can be altered and controlled.

  Augmented reality systems can reduce the amount of time required to orientate and train new employees, as well as bridge any language barriers with migrant workers.

* Carmigniami et al. (2011): Augmented Reality: An Overview. In: Carmigniami; Furth (eds.): Handbook of Augmented Reality, Springer, New York, 2011, pp. 3-46

Augmented reality:

- **Limitations**

  Number of technical and business challenges exists

  - Battery life
  - Network performance
  - High implementation costs

  Development of an AR pilot product for logistics is delayed by a lack of hardware equipment for real time tracking of people in a warehouse environment.

- **TRL**

  TRL level for фгпьутеув куфдшен technology used in logistics could be 6. There are some projects and prototypes to use it in different business areas. But these projects not yet on full production use level due to various technology limitations still exists

3PL operator challenges vs technologies

Minimizing lead time between deliveries	• Big Data, IoT, PDA/Tablets
Ensuring latest IT and automation systems	• EDI, PDA/Tablets, Optical recognition, IoT, Drones, Robots, AU
Flexibility	• Augmented reality, EDI, IoT
A motivated workforce.	• Drones, robots, Augmented reality

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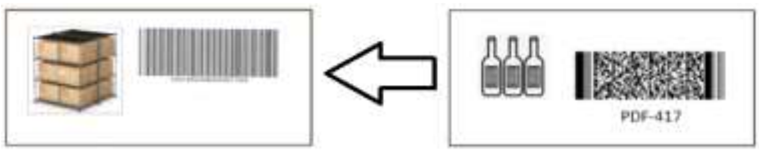
Case-study 1:

- **Problem description**

Baltic region have warehouses who performs transit of alcohol goods to Russia. During the transit operations excise strip stamp labeled to the bottle.

Russian authorities would like to trace every bottle of alcohol imported to russian market. Alcohol importers need to send to the system called EGAIS infomation about excise strip stamp number and to which pallet SSCC code it is linked. In other words 3PL operator need to provide tracing from the bottle up to the pallet level.



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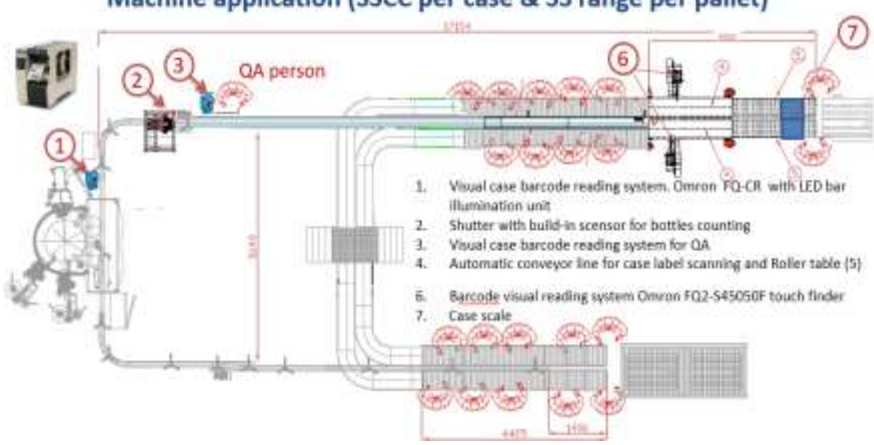
Case-study 1:

- **Solution**

Machine application (SSCC per case & SS range per pallet)



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Case-study 1:

- Benefits

Name	Before	After
Strip Stamp information on order level	Yes	Yes
Strip Stamp information on pallet level	No	Yes
Strip stamp information on batch number level	No	Yes
Pallet SSCC codes	No	Yes
Cartons SSCC codes	No	Yes
Measurable QA process	No	Yes

Usually by increasing detalisation level of the information system processing takes more time as user need to enter information or make stops and checks at the some points. One the the project targets was to keep current production speed and increase system detalisation level.

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Case-study 2:

- Problem description

The importance to have information on delivery accurate and on-time is considered quite high in B2B and B2C segments.

It is also essential for managing supply chain and delivery network. With the aims of being fast, safe, controllable and traceable, delivery and trucking companies have developed a quite different logistics network and systems in their logistics process. Implemeting of such processes requires a lot of resources from finance and IT perspective especially in SME.

Presented service that can be used and shared between delivery companies, 3PL operators and consignors and consignees to get IoD (information on delivery) accurate and on-time without implemeting high costs and complicated processes and IT systems.

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Case-study 2:

- **Solution**

Created IoD (information on delivery) data exchange platform. Consignor have to label goods with QR-code where encoded address and of the platform and package number.

Driver with help of mobile application should scan this code when goods delivered. This will trigger information to the consignor. Before scaning bar-code some additonal information can be entered by delivery service to send it togather with IoD.

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Case-study 2:

- **Benefits**
  - IoD information at the same time when delivery happened
  - Fast implementation
  - Low investment costs
  - No need for complicated IT solutions in organisation

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Conclusions

- Right technology and process have to be used to improve and automate 3PL operations and become more competitive on the market
- Technology use can decrease 3PL business dependency on labour costs. As labour now is one of the biggest 3PL problems on east european market
- Technology use can control and increase product quality
- Technology use in logistics helps magement to take right decisons right time (Big Data, AI – DSS)

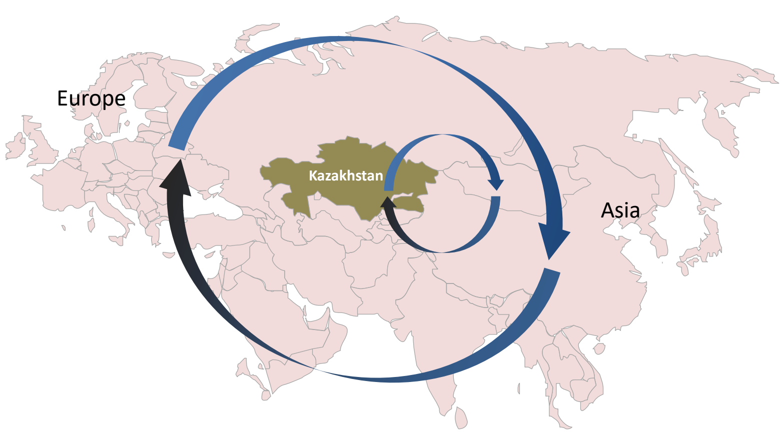
Thank you for your attention!

Development of the road transport Prospects in Kazakhstan as part of the "Nurly Zhol" strategy

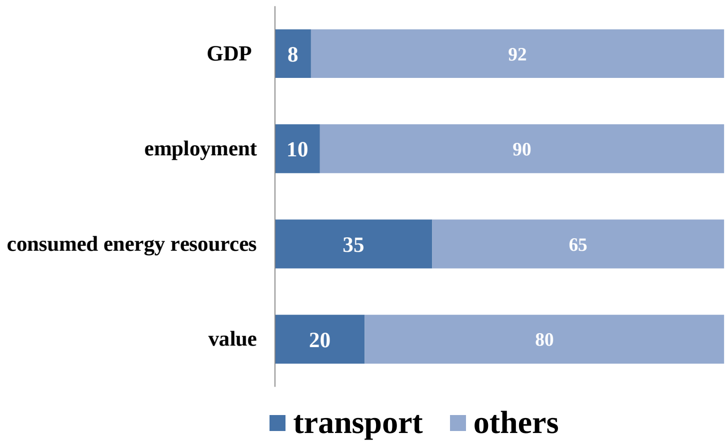
Gani Askarov, Utegali Shedenov
Al-Farabi Kazakh National University

Jurijs Tolujevs
Transport and Telecommunication Institute

The volume of trade between Europe and Asia in 2020, 1.2 trillion US dollars



Transport in Kazakhstan is one of the basic infrastructure industries

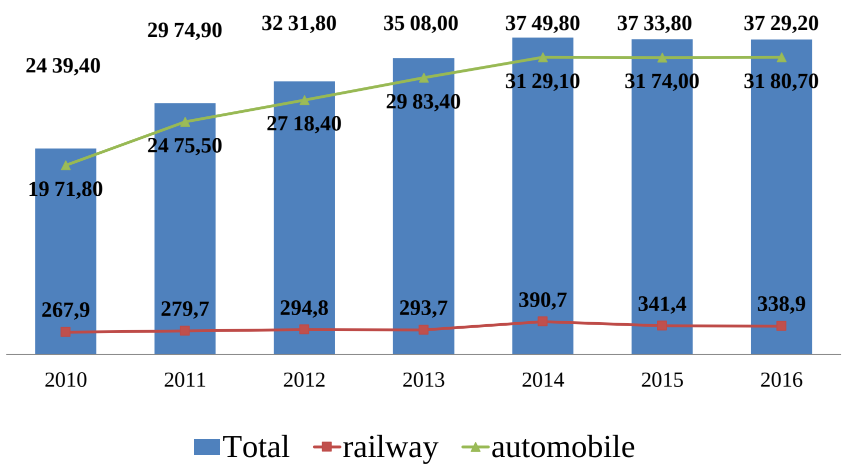


Development prospects of road transport in Kazakhstan as part of the strategy "Nurly Zhol."

Table 1 - Transportation of goods in the Republic of Kazakhstan for the period of 2010-2016 (in million tons)

	2010	2011	2012	2013	2014	2015	2016
Total	2 439,4	2 974,9	3 231,8	3 508,0	3 749,8	3 733,8	3 729,2
including:							
railway	267,9	279,7	294,8	293,7	390,7	341,4	338,9
automotive	1 971,8	2 475,5	2 718,4	2 983,4	3 129,1	3 174,0	3 180,7
inland water	1,1	1,1	1,3	1,1	1,3	1,2	1,2
pipeline	194,0	214,1	213,2	225,9	225,0	214,6	205,8
marine	4,7	4,6	4,0	4,0	3,6	2,5	2,6
air, thousand tons	28,9	31,6	22,0	23,9	19,1	17,2	18,0

Transportation of goods in the Republic of Kazakhstan for the period of 2010-2016 (in million tons)



Development prospects of road transport in Kazakhstan as part of the strategy "Nurly Zhol."

Table 2 - Amount of trucks in the Republic of Kazakhstan for the period of 2010-2016, unit

2010	2011	2012	2013	2014	2015	2016
397 598	414 018	428 862	450 178	434 665	443 161	439 167

The main road transport routes in the territory of Kazakhstan

Today the extent of highways of the Republic of Kazakhstan is about 130 thousand km.

Place of Kazakhstan in LPI rating since 2007

	2007	2010	2012	2014	2016	2020
At the first place	**Singapore**	**Germany**	**Singapore**	**Germany**	**Germany**	**?**
Kazakhstan	133	62	86	88	77	**40?**

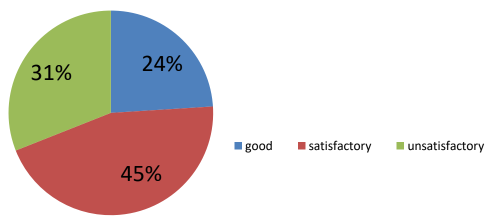
Criteri`s of the LPI index:

- the efficiency of customs;
- quality of trade and transport infrastructure;
- ease of transportation organization;
- competence and quality of logistics;
- the ability to track and track cargo;
- timeliness of delivery of goods.

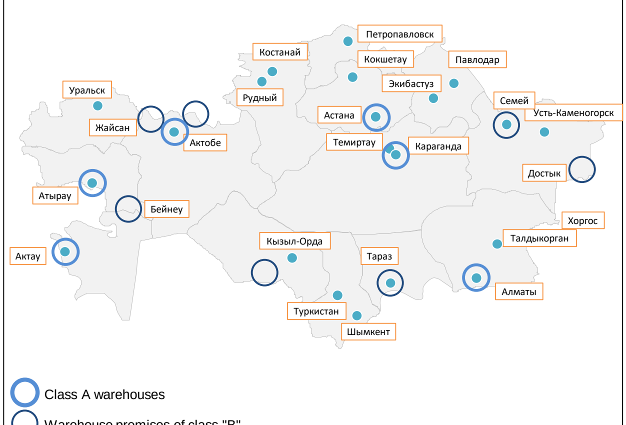
Roads category in the Republic of Kazakhstan

Classification of roads	Total prosthetics, km	Of them by category					
		I	II	III	IV	V	Without coatings
Republican	23500	1529	4756	16335	653	120	107
Local	74373	67	3579	22754	40078	3422	4473
Total	97873	1596	8335	39089	40731	3542	4580

Technical condition of highways in the Republic of Kazakhstan



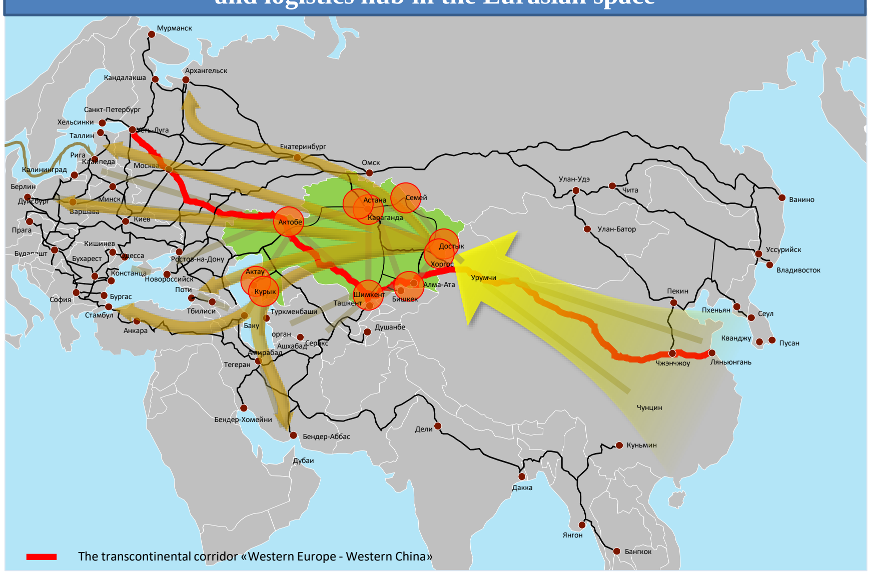
Map of the largest existing storage facilities and terminals of the Republic of Kazakhstan



- 19 transportation and logistics centers in the Republic of Kazakhstan;
- The bulk of warehouse and terminal areas in the Republic of Kazakhstan refers to infrastructure class "B".

The State Program for Infrastructure Development until 2020 "Nurly Zhol"

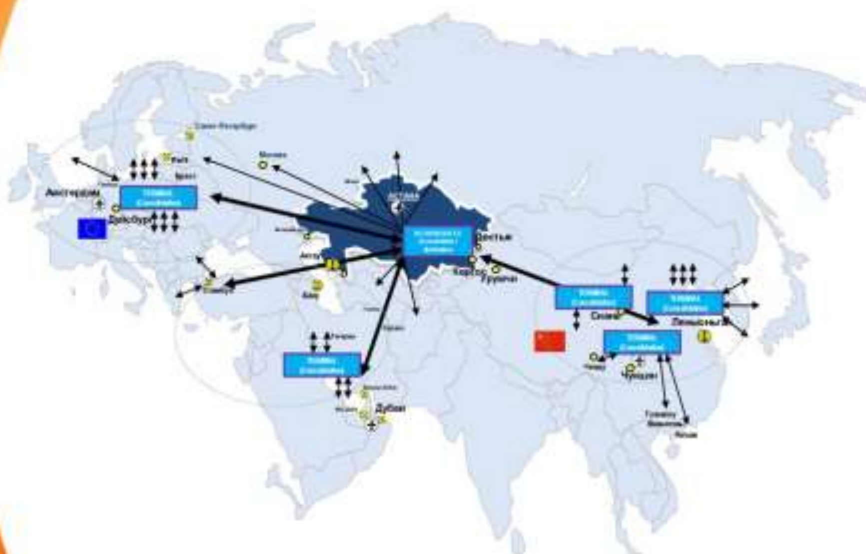
The strategic positioning of Kazakhstan in 2020 is a powerful transport and logistics hub in the Eurasian space



Construction and reconstruction of roads in the program

Construction and reconstruction of roads in the program

“Dry” port SEZ «Khorgos - Eastern Gate"



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Regional Centre for Development of Almaty region

Thank you for attention!

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