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ANALYSIS OF SUSTAINABLE FREIGHT AND PASSENGER ROAD TRANSPORT DEVELOPMENT USING *ITS*

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The paper presents an analysis of measures to be taken for development of sustainable transport system. Increasing traffic intensity unavoidably requires faster development and modernisation of transport infrastructure, which means not only larger investment but also better transport policy and introduction of more advanced solutions, such as promotion and deployment of ITS – intelligent transport systems and services.

In Lithuania for development of a modern transport system meeting the EU standards and criteria, the key priority is given to development, rehabilitation and modernisation of those transport infrastructure objects that form an integral part of TEN-T. Another as much as significant task is to improve road, railway, water and multimodal transport infrastructure of national and regional significance in order to cope with the growing mobility needs of the society, promote development of business and tourism, and increase competitiveness of the economy. In recent years the ITS deployment policy have been strongly promoted in the national level. Road safety is a further area where substantial improvement is needed, despite significant achievements in the past. Application of ITS is seen as one of the most effective tools in order to improve traffic safety and other areas of transport.

Keywords: sustainable, multimodal, intermodal transport, P&R, ITS

1. Introduction

Multimodality is one of the key elements of efficient transport systems, especially in terms of urban traffic. A sustainable transport system is achieved in case if the priority is given to multimodality. The European Commission draws attention on the following figures: urban transport accounts for 40% of CO_2 emissions of road transport and up to 70% of other pollutants from transport; one in three road fatalities occurs in cities; congestion problems, too, are concentrated in and around cities [1]. Transport policy-makers must find right methods to increase mobility and at the same time to reduce the negative effects of public, private and freight transport (congestion, accidents, noise and pollution). The answer to that is the development of sustainable multimodal public, private and freight transport systems. In passenger transportation we describe multimodal journey the one that involves more than one type of transport (it is recommendable to involve as many modes as it is necessary for seamless transportation). The similar term of intermodality more refers to the ability to seamlessly switch between transport types with limited waiting times and smooth transitions [2]. In freight transport multimodal transport is defined as the carriage of goods by at least two different modes of transport. Intermodality in freight transport refers to movement of goods (in one and the same loading unit (containers/swap bodies) or a vehicle) by successive modes of transport without handling of the goods themselves when changing modes. Intermodal transport is therefore a particular type of multimodal transport [3]. When we talk about sustainable multimodal systems, usually it encompasses both terms. Sustainable multimodality leads to a better productivity and attractiveness of public and freight transport and positively influences people's mobility and strengthens transport role in the economy**.**

Problems such as traffic congestion, global warming and environmental sustainability are forcing to review long-term plans for transport. The main aim must be developing and improving the safety, security and effectiveness of the transportation systems where we can, building on the investments made in past decades. At the same time we must anticipate and be ready for the problems and challenges that are ahead. This is where ITS can play a vital part [4].

2. Sustainable Road Transport

Road vehicles provide much better protection for their drivers and passengers than was the case a decade or even several years ago. Nevertheless there is still much to do in order to improve protection of vulnerable users in the event of accidents. Intelligent Vehicle Safety Systems (IVSS) – or the so-called eSafety systems, are new automotive systems combining mechanical, micro-electric, communication and information technology and are aimed at significantly reducing the road accidents rate and its consequences. The eSafety initiative established in April 2002 as a public-private partnership of the European Commission and industries having an interest in information-based road safety systems, e.g. car manufacturers, road operators, telecom companies and transport service providers have already shown a huge potential of ITS deployment to increase the traffic safety. These systems use information and communication technologies for vehicle safety. The eSafety initiative has defined a list of the most effective IVSS systems (eSafety systems). The chart below indicates the grouping of these systems by vehicle-based and infrastructure related systems [5]:

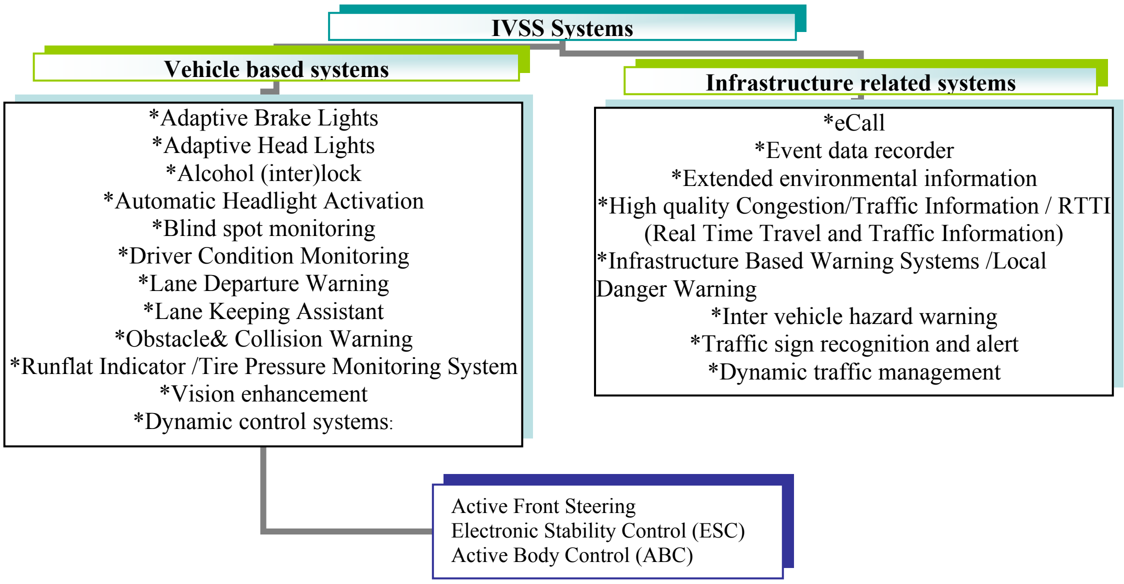

Figure 1. IVSS systems

According to Eurobarometers' survey initiated by the European Commission, overall drivers well perceive a usefulness of IVSS. Given the question on which IVSS they would like to have in their car, the majority would like to have each of the 10 provided at the survey [6]. The share of drivers that would like to have IVSS, even if they think it is not a useful system in their car, ranges from 75% concerning ABS to 52% concerning lane departure warning system. Good results let us hope that this would change the situation in traffic safety and significantly reduce the number of the lethal accidents on the roads. The need of ITS in drivers perception is a huge step towards massive ITS deployment in all areas, be it public, private or freight transport.

To make it most effective, road transport must be seen as a part of an overall transport system, with effective links to other modes [7]. The demand for road transport and mobility continues to grow, and must be met within the constraints of congestion and environmental challenges including greenhouse gases and noise. At the same time, effective and reduced use of energy is needed to contribute to security of supply. Road safety is a further area where substantial improvement is needed, despite significant achievements in the past. Application of ITS is seen as one of the most effective tool to achieve this [8].

Environmentally friendly transport system first of all refers to promotion of eco-transport. In many cases this is seen as effective network of bicycle lanes and use of electro-powered transport vehicles, such as light rail systems, urban trains, trolleybuses, eco-friendly freight transport vehicles, etc. In recent years, new trends of measures to reduce negative impact of environment have been emerged: promotion of bio-fuels, use of information systems to replace a need for transport (concept of "communication instead of transportation"), private-public journey model ("park and ride" concept), and intelligent traffic management systems to eliminate or avoid congestion and improve traffic flow control. Well-developed public transport network and interaction between private and public transport complements measures for efficiency. There are obvious advantages of the public-private concepts such as "park and ride" (P&R), "bike and ride" (B&R) systems, effective deployment of parking lots, night-transport network, car sharing programmes. Dense network of footways and bicycle lanes also play important role in a multimodal system.

2.1. Sustainable freight and passenger road transport system

In the nearest future the EU will face increased demands for personal mobility and freight transport. An internationally competitive, efficient, and cost effective transport system is essential in an expanding EU, and hence continued investment in intermodal links and capacity between road, rail, water and air is critical. With congestion already a problem in many cities and main transport corridors in the EU, even moderate growth predictions represent tremendous challenges.

In the EU, road transport is a clearly dominating means of transport both in terms of passenger and freight transportation. In freight transportation road transport accounted for the single largest share (44 %) in 2005, sea transport was not far behind with a share of 39 % [9]. The road transport share in the EU accounted for about 84 % of passenger transport performed in 2004 when passenger cars, powered two-wheelers (P2W) and buses and coaches were taken together. Road infrastructure is one of the key factors determining efficiency of transport operations and having vital significance for the Lithuania's socio-economic development as well. In Lithuania over 50% of all cargoes and nearly 98% of all passengers are carried by road. Lithuania has a very similar market share of road and rail companies in terms of cargo transportation. However, quite inadequate situation is seen in the modal split of passenger traffic: road transport takes almost 98 percent of all market. The reason is that the railway infrastructure for carrying passengers, experiences only an initial phase of modernisation; network of railway lines is not dense enough. Also it should be mentioned that the level of motorization booms. Reflecting the European policies, efforts today are taken to balance passengers' traffic modal split, between road and rail. A number of newly-registered cars are growing substantially: since 1990 the road vehicle fleet has grown 2.1 times, while traffic loading has increased by 119% on average. All this calls for a faster implementation of ITS.

2.2. Sustainable urban public transport

In the field of urban passenger transport, there is an increasing demand from European citizens for individual mobility, but at the same time society as a whole must reduce the environmental impact of road transport and increase its efficiency. The EU strives for a clean, energy-efficient, safe and intelligent road transport system. Despite efforts to promote the popularity of other transport modes, notably in congested areas, the car remains the personal means of transport par excellence, allowing people to get from A to B when and how they want; a growing independence that has meant concomitantly a dramatic increase in the number of passenger cars [10].

There are no any efficient urban transport network without public transport. Otherwise, all the cities would have faced with unavoidable and invincible congestion phenomena. Nevertheless, public transport succeeds to attract users only if a set of urban public transport characteristics tilt the balance of advantages compare with personal cars. Prof. J. Sussman accentuates these factors (variables) [11]:

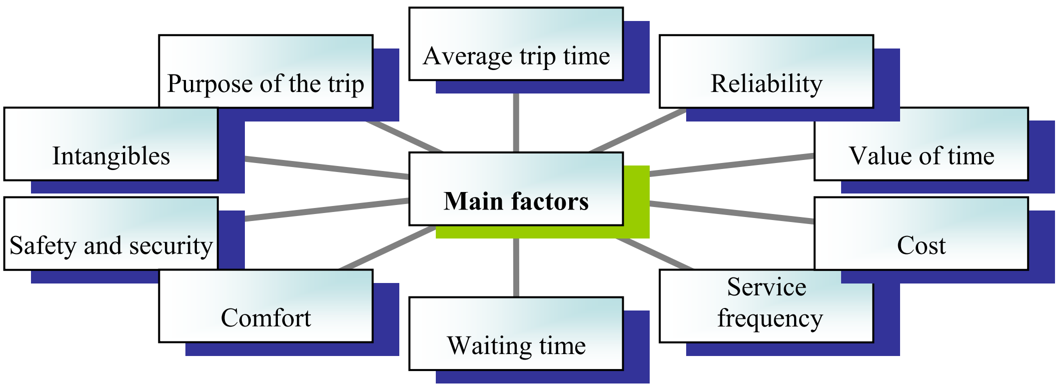

Figure 2. Main factors influencing the choice of urban transport type

The aim of decision-makers is to draw attention to those factors that are considered as the main obstacle in passenger's mind when it comes to choosing a transport mode to perform one or another journey. The ITS therefore should be deployed firstly to remove these obstacles as, for instance, the deployment of real-time traffic information systems turns waiting time factor into positive, because a passenger might quite easily plan a multimodal trip (provided that frequency of service is perceived as good enough). The transport links should be developed rationally enough for ITS to give a strong effect. The scheme below illustrates a streamlined model of transport links.

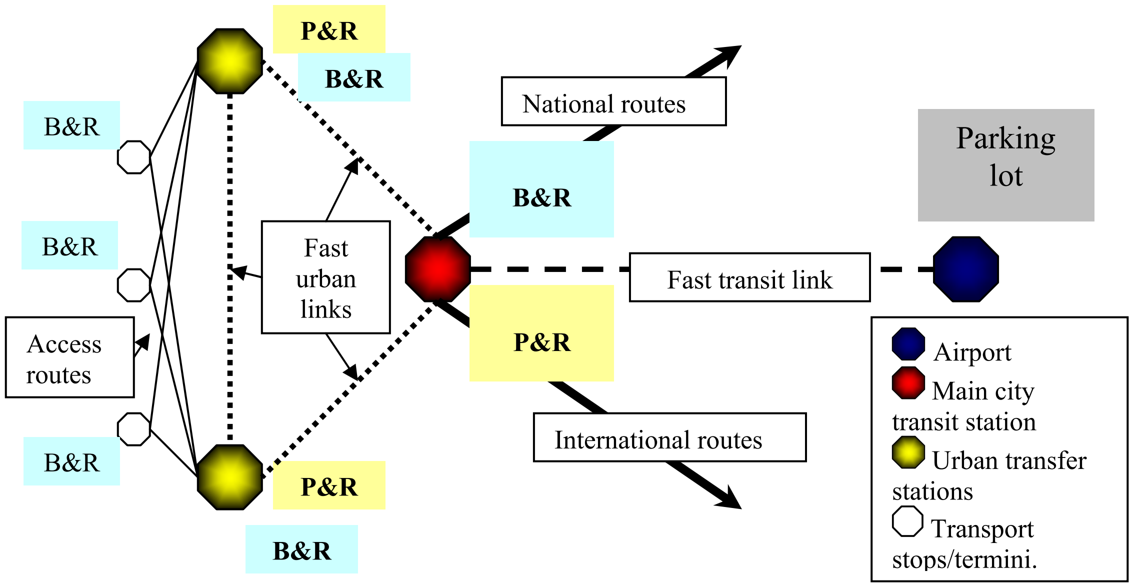

Figure 3. Model of effective urban transport links

In practice, urban transport network has to have fast public transport links in order to eliminate (reduce) congestion in the main transport arteries. Those links connect main urban passenger terminals (stations) with the main city station (main passenger train terminal with multimodal links) which is in turn linked to usually outside the city located airport by fast transit link and as well serves for international and national traffic. In order to effectively control transport flows, city is not possible provide with no-transfer links. The outermost areas of the city, especially not densely populated ones, are usually linked to urban transfer stations (light rail or urban rail station, the bigger ones bus terminals) by bus routes (bicycle lanes is a supplementary option, too). For those residents who have no frequent or convenient public transport links to fast urban links, P&R areas are provided to park their personnel car and to further continue journey by fast urban transport. This system is rather complex mechanism than easy-to-achieve goal. The ITS deployment in public transport has been seen as a necessity to manage more and more complex public transport.

3. Conclusions

Transport flows on main roads and urban streets are constantly growing all over Europe, congestion becoming a threat of traffic safety. Therefore ITS are seen as an effective solution to implement the concept of sustainable mobility.

Traffic management and travel safety does not meet the growing demands of traffic actors, ITS services are not yet efficiently delivered to travellers in Lithuania.

Private and public transport interaction systems, such as “park and ride”, especially at vicinities of the city helps to avoid congested street and promotes the use of public transport. “Bike and ride” option is seen an attractive as the way to access the nearest public transport terminals, where landscape is favourable.

Involvement of urban transport stakeholders must ensure that all of them participate in management of transport systems in a co-operative way. Organisational structure has to ensure that transport managers and operators know passenger’s need and get a feedback constantly to be able timely react.

Implementation of the intelligent transport systems and services greatly affects all the factors influencing urban journey and leads to sustainable functioning of multimodal urban transport systems.

In order to achieve sustainable mobility, effective innovative measures have to be introduced to ensure shifts to more environmentally friendly modes where appropriate, especially on long distance, in urban areas and on congested corridors, but at the same time each transport mode must be optimised.

With the expanded geography of the EU a need for new intra-European corridors will come, as well as a general reinforcement of the existing international freight transport routes. The expected investment in linking the East and the West offers a rare and significant opportunity to create an innovative and efficient infrastructure. It seems that ITS deployment has the biggest rational, especially improving the situation of road traffic safety. Road transport is the key element of the entire transport system. Therefore it is of vital importance to increase effectiveness of this sector and achieve the goals of having road transport as a part of the entire multimodal transport system.

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IMPROVEMENT OF URBAN TRANSPORT ACCESSIBILITY FOR THE PASSENGERS WITH REDUCED MOBILITY BY APPLYING INTELLIGENT TRANSPORT SYSTEMS AND SERVICES

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Deployment of Intelligent Transport Systems and Services (ITS) has been strongly considered as crucial element of improved accessibility for passengers with reduced mobility. Intelligent transport systems in the light of improving an access to urban transport for passengers with reduced mobility are analysed in the article. The need of deployment of these systems in three areas – information, infrastructure and vehicles is emphasized and practical examples are provided. Only in the case if intelligent transport systems are deployed in all the three areas, a seamless transportation for the disabled people is ensured. The aim of the research is to evaluate solutions, encouraged by the EU transport policy and proved by a good practise that might be implemented in Lithuanian urban transport system. These solutions are also based on results of questionnaire, accomplished by the author.

Keywords: mobility handicaps, reduced mobility, sustainability, Intelligent Transport Systems

1. Introduction

Accessibility is the main element of a sustainable transport system. European Commission encourages forms of public transport accessible to all users, including people with reduced mobility (especially those with disabilities and the elderly ones) [1]. Nevertheless, there are too many obstacles for the people with reduced mobility as regards the transport accessibility: switching between modes, information services, pedestrian environment, traffic safety and others. Until these obstacles are not eliminated the vast majority of disabled people will continue to stay at a disadvantage and will be unable to travel as they would wish and consequently limited in the extent to which they can participate in society [2].

Mobility handicap is a broad term – it includes people who by some reason (it might be accident, certain disease, congenial condition or disability) have difficulties to move around [3]. Virtually everyone of us has or will have a certain degree of reduced mobility (due to temporary impairment, senescence, injury, etc.) therefore a good design of transport system leads to better quality of all passengers. The best example of this was introduction of low-floor buses – designed as an effective solution for passengers in wheelchair they brought significant benefits for all passengers due to faster, safer and easier boarding and disembarkation. The demand for mobility is the biggest in urban areas, this notwithstanding, whole transport chain should be adapted to seamless transportation, including aviation, trains, water transport and transport on demand. ITS might help to remove the most of the barriers in a very efficient way. Other perspective option is to facilitate accessibility to e-services, thus giving a possibility for people to use communication services (e-purchase, e-banking, etc.) instead of the need for physical transportation.

Development of intelligent transport systems to inform passengers with reduced mobility of transport conditions should eventually help reduce the time lost on transferring between modes or access to the stops and stations. There are about 30,000 persons in Lithuania who cannot receive and process information in the usual ways, because of their disabilities [4]. In the past decade no efforts have been made to adapt the information environment to the needs of such persons. Because of their low levels of income, disabled persons have limited opportunities to acquire the equipment necessary for the use of the internet and to cover user costs.

Public transport needs to achieve levels of comfort, quality and speed that come up to people's expectations. This quality option has been the choice of many European cities which have decided to innovate by bringing into service new metro or light railway lines or new buses with easier access for people with reduced mobility.

According to outcomes of studies, Lithuanian transport system is not well adapted for people with special needs. Moreover, only 55 per cent of population can use the present transport system in an absolutely seamless and accessible way [4]. This means that much has to be done to achieve better level of sustainability in transport, especially in urbanised areas.

The aim of the research is to evaluate solutions, encouraged by the EU transport policy and proved by a good practise that might be implemented in Lithuanian urban transport system. These solutions are also based on results of questionnaire, accomplished by the author in April 2007. The respondents (the disabled passengers) were asked to evaluate the level of quality of information provision services, the adaptation of transport infrastructure and vehicles, pedestrian and living environment. These results allowed indicating the most problematic obstacles for transport accessibility and find the most suitable ways of ITS application for removing of those obstacles.

2. Results of the Research

The results of the research allowed indicating the most problematic obstacles for transport accessibility in Vilnius and find the most suitable ways of ITS application for removing of those obstacles.

Group of respondents – wheelchair users – were asked to provide answers to questions related with Vilnius public transport system. In total, 52 respondents gave their answers and comments.

Results of the questionnaire showed that the vast majority of wheelchair users – over 50 % – never travels by public buses or trolleybuses (see Figure 1) in Vilnius. This is the main problem needed to be solved – how to improve their accessibility to public transport.

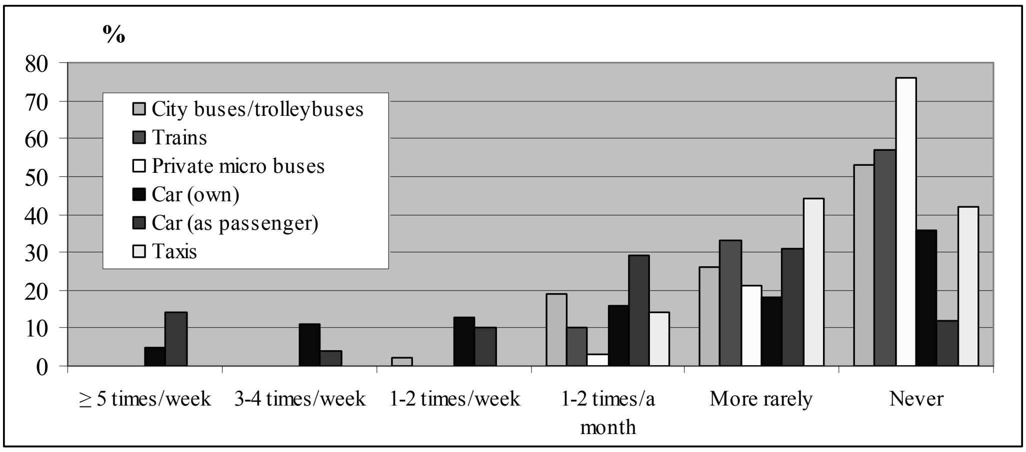

Figure 1. Frequency of trips performed by wheelchair users in Vilnius

Improvement of accessibility for people with reduced mobility is a very complex question. The authorities have to deal with adaptation of transport infrastructure, dwellings (lifts, elevators), pedestrian infrastructure and other related issues. As concerns the main reasons for not choosing the public transport, the respondents indicated physical restrictions (36 %) and a need of accompanying person (30 %). See green column, Figure 2:

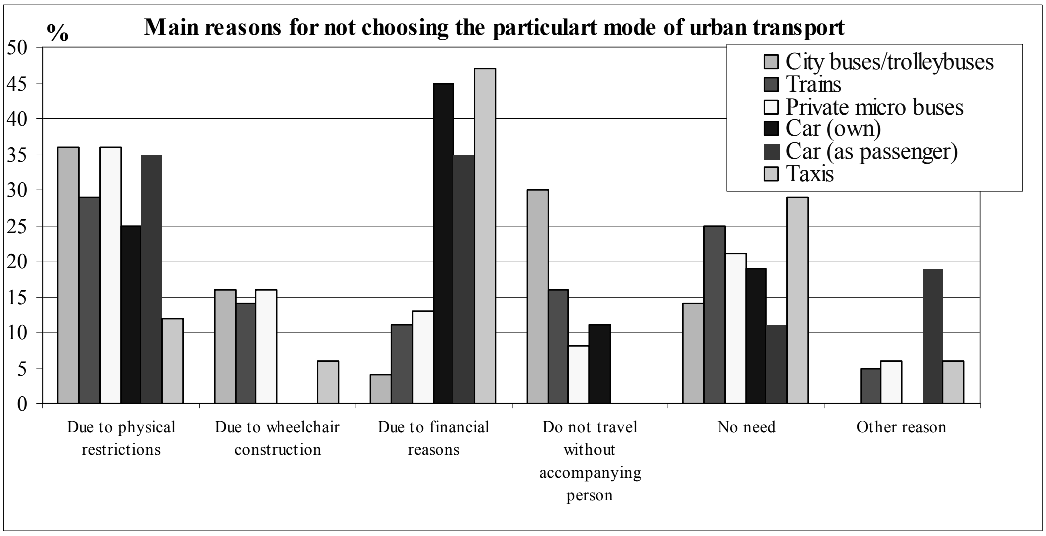

Figure 2. Answers of wheelchair users on the main reasons for not choosing the particular mode

To summarise the percentage of those who never travels without accompanying person and those who do not have a need for travelling by public transport, circa 45 % of wheelchair users are not potential public transport users in a nearest future. Nevertheless, the efforts must be done for those who cannot travel at all, or travel with heavy difficulties, due to physical restrictions, wheelchair construction or financial reasons (in total 55 %).

Railway transport is not an integrated part of public transport in Vilnius. Therefore, the answers should be treated as intercity trips.

Wheelchair users are, of course, only a small part of people with reduced mobility, in terms of percentage. But the results showed that these people still does not have accessible transport. The same is true for people with other disabilities – blind people, people with reduced coordination, strength, partially sighted and others. There is a lot of room for improvement, and ITS is a solution to facilitate the travelling for people with reduced mobility.

The next chapter analyses possibilities for improving the transport system for the people with reduced mobility (including wheelchair users)

3. Nature and Degree of the Problems Concerning Passengers with Reduced Mobility

Intelligent transport systems, when implemented within transport system, play a crucial role for passengers with special needs. Vast majority of impaired persons need a special equipment to be able to travel by public transport, especially in the light of underground transport. They also need specific provision of information (visual or audio) and easier access to transport terminals. Although the special equipment is a must, the facilitation of travel is a complex process: in order to ensure a seamless transportation for the disabled persons ITS should be used leastwise in these three main areas:

1. Information;
2. Infrastructure and pedestrian environment;
3. Vehicles.

The first area – information – is described as a bunch of different methods of provision of information both on-board and outside the vehicles. The information is needed for evaluating the possible choices and then making decisions about the journey. The second one – infrastructure and pedestrian environment – encompasses the measures targeted for accessing stops and stations, for changing between modes, for moving in the terminals, reaching the information desks and other necessary places. And the last one – the vehicles area – encompasses systems that aims at facilitating a circulation within the vehicle, seating and sleeping accommodation, boarding the train, access to the facilities and services on the train (catering, lavatories, etc.).

The planned journeys might involve the use of multimodal transport, i.e. more than one mode of transport. But for the disabled persons, it seems not rationale journey, as it is difficult to interchange from one mode to another. Even information system is not adapted to multimodal journey. Therefore in developing comprehensive transport information system, it is of great importance to include information on intermodal as well as within one mode accessibility (would it be leaflet, brochure, internet web page, SMS inquiry, trip-planner programme, phone info-centre, or whatever else).

The White Paper on European Transport Policy suggests taking account of the difficulties encountered by people with reduced mobility that use public transport and for whom changing from one mode to another can sometimes be a real obstacle. It is worth to be mentioned that many problems might be caused by ineffective interaction of the three above-mentioned areas. Seamless transportation for the disabled persons is only achieved if intelligent transport systems and services are implemented and applied in all three areas and all the modes of urban transport system. Accessibility is about the usability of the public transport system as a whole. Thus it includes issues as the accessibility of the destination by public transport, the safety of travel, the services provided by the staff and the information available to passengers. The objective of improving the accessibility of public transport is to realise equal travel and mobility opportunities for everybody.

The people with reduced mobility represent roughly up to 30 per cent of the population in the European Union. People with reduced mobility include older people, people with reduced strength and temporary impairment, pregnant women, etc. People with physical impairment represent about 12 per cent of the EU population.

The table below indicates the percentage of impaired persons and respective intelligent solutions aimed at facilitating an access to rail transport:

Table 1. The number of impaired persons and respective ITS aimed at facilitating an access to urban transport

Nr	Nature of impairments	Percentage of impaired persons in the EU-27	ITS aimed at facilitating a use of rail transport
1	Wheelchair users	0,4 %	Autonomous systems for bridging the gap (bridging plates, special ramps), lifts for boarding and circulating in the terminals, automated systems instead of manual ones, wheelchair-lifts. Adapted ticket vending machines and information retrieval desks (parameters should allow convenient use of latter's).
2	Cannot walk without aid	5,6 %	
3	Cannot use fingers	0,1 %	
4	Cannot use one arm	0,1 %	
5	Reduced coordination	1,4 %	
6	Reduced strength	2,8 %	
7	Language impaired	0,6 %	Info-lines, signs, many other systems that are used for people with different impairments.
8	Without speech	0,3 %	
9	Dyslectics	3,1 %	Voice announcing systems, acoustic information instead of text-based ones.
10	Intellectually impaired	3,8 %	Assisting systems that are easy to understand and follow instruction, trained personnel.
11	Hearing disability	0,1 %	Different kinds of information provision based on visual perception and other equipment like the mobile phone, text phone, videophone, monitors or electronic signs. Advanced visual systems.
12	Hard of hearing	10,0 %	
13	Blind people	0,1 %	Special assisting systems for visual disabled persons helping to access to rail terminals and trains, equipment with Braille features, voice announcement systems, tactile surfaces and guide paths. Special ticketing systems (ticket vending machines with the Braille features).
14	Partially sighted	1,4 %	

The number shall not be summarized, bearing in mind that many people have more that one impairment (multi-disability). This makes the access to transport yet more complicated. The table helps us to understand to what extent the problem of accession the public transport, including underground urban transport and rail, is serious. State-of-the-art equipment and well-chosen interaction of intelligent transport systems and services in all three applied areas strive to solve the problem by introducing in practice lots of successful solutions. In the next chapters the authors scrutinized only the solutions that have already been successfully introduced.

In order not to overlap with the systems analysed in other two areas, the information provision here is understood both as advance information and information provision on-board and along the guiding route to the vehicle. At the first glance it seems that information provision is not a serious obstacle, but just imagine in what extent the information (esp. real-time) for railway passengers is important: usually the information for rail passengers with reduced mobility is needed on places to buy tickets, lavatories, steps, lifts, elevators, nursing rooms, luggage storage, information service, guidance assistance, waiting halls, where/what will be announced audibly, guide paths for the blind, signs, train timetables, other train station facilities and etc [5]. This is essential information for these travellers; hence the rail transport operator should ensure that advance information can be ordered to theirs home or workplace by mobile phone or SMS or via the Internet in advance, before the journey, making it possible to anticipate the whole travel chain.

The main difficulties in highly urbanised areas are associated with visually impaired passengers that have to deal with very problematic tasks that may not seem difficult to other passengers, but usually is an obvious obstacle for them to travel. They need to get on time the specific information due to their inability to go/move faster. This information not necessary is possible to provide in advance over the portable devices or provide in the Internet. If it is not possible, when it is recommended to introduce signs, audible and visual information screens, on-board displays, loudspeakers in the train stations, their vicinities and vehicles themselves. This would comprise the information on:

- finding a station, stop or terminal;
- navigation inside the terminals and vehicles;
- perceiving the arrival of the correct vehicle at the platform, terminal, stop;
- finding the door of the vehicle and finding one's way into it;
- paying for services;
- finding a seat, berth;
- obtaining information during the journey;
- disembarking at the right stop or station;

- navigation inside the station;
- finding the exit,
- finding the destination .

In terms of information provision, any group of the disabled persons shall not be neglected. The only one solution is to use multiple channels of information (audible, visual, information desk equipped with the Braille). The picture below indicates some practical suggestions on information desks where concrete information on the aforementioned questions might be obtained (it is true for ticket vending machines as well):

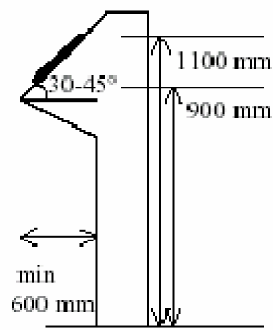

Figure 3. Recommended parameters of information desks

These information desks should be equipped with touch screens, integrated audio systems and the Braille option, besides have special parameters in order to provide the information for as many people as possible. Accessible with a wheelchair, equipped with a modern touch – screens, ordinary keyboards or ball mouse, convenient both for tall and short people, adapted for people with mobility, hearing or visual disabilities these information desks allow reducing costs of personnel:

Not importantly in whatever form the information is possible to be retrieved; it always must meet four criteria to ensure the seamless transportation: 1) Clear; 2) Accurate; 3) Timely and 4) Concise.

The infrastructure and pedestrian environment should be conveniently designed infrastructure that allows quickly finding the right information and using the right transport services. Where are the lifts, ramps and escalators? The plan of terminal should be planned taking into account the disabled passengers, for whom a circulation in it may pose many questions.

The biggest problems of circulating within the transport chain concern the blind. Intelligent transport systems like the system used in Utrecht Central Station (the Netherlands), or the system at Leeds City Station in the United Kingdom, enable visually impaired people to navigate around a station complex on their own. These systems are triggered by smart cards and provide the visually impaired person with spoken information either to a headset, or aloud. They are most useful when combined with a tactile surfaced guide path as in Utrecht. The safe circulation inside the terminal and safe boarding and disembarkment are seen as the crucial issues. The last but not the least is an issue of guidance in alarm-situations. Therefore, all the exits, space available, guide paths shall be very precisely projected for the disabled passengers.

Boarding and alighting the vehicle usually means that passengers have to get through the door and negotiate a few steps. Steps and gaps are usually a real barrier to people in wheelchairs and even to people with severe walking difficulties. The functional capabilities for passing over the gap between the platform (or pavement) and the vehicle floor have been intensively investigated in laboratories in France, Germany and Great Britain by mobility impaired people and wheelchair users who were used to moving around in the city and reaching the train station. These tests helped to design the requirements that were determined as follows [5]:

• The horizontal and vertical gaps shall be not greater than 100 mm (*50 mm is preferred*) and 50 mm respectively for people in wheelchairs;

• The horizontal gaps shall be not greater than 300 mm for people with severe walking difficulties;

Where level access cannot be achieved, technical and operational solutions for boarding/alighting should be used in order to overcome the steps and gaps. These lifts are adapted to different platform heights, so it is applicable in differently projected stations. Simple and inexpensive option for lifting the disabled passengers is access ramps (see the illustration below of the ramp used in Norwegian State Railways Company) that have an advantage against the lifts in the light of self-boarding:

Figure 4. Access ramp

This is usually limited option because of the height issue – the greater difference of height between coach floor and platform, the harder boarding into the train or other vehicle for the disabled passenger. If the difference is too great (too low angle), the assistance is necessary. Usually only one coach modified for wheelchair users, with access ramp to board and alight the train. The ramp is delivered as a compact cassette, integrated in the floor of the entrance area, containing frame, telescopic arms and the ramp. Some main characteristics of this ramp are given in the table below [1]:

Table 2. Some main characteristics of access ramp

Characteristic	Dimension
Dimension of the access ramp	80 cm x 333,6 cm
Dimension of the cassette	100 cm x 175 cm x 11.2 cm
Activation of the ramp	Electronically in driver's cabin while in use
Capacity	Up to 450 kg
Operation time	Max. 45 s
Work conditions	Snow, ice, water, sand.

If electronic ramp is too expensive to introduce, manual ramps are also used. There are two types of manual ramps:

1. Manual demountable, which is carried on the carriage and put in position when required;
2. Manual fixed which is folded out by the staff when needed.

Both of these two manual ramps have their own advantages and drawbacks: The manual demountable ramp is not fast to mount in the entrance. Nevertheless it is cheaper than the second one and might be mounted to any entrance of the vehicle.

The ramps and lifts are used if only vertical gap between platform and floor of the vehicle exists. Otherwise, the bridging plates (manual or electronic) are enough. As practice shows, the substantial improvement of accessibility is achieved if platforms of the stations and floors of carriages are at the same level and the horizontal gap (if greater than 5 cm) then is filled by a bridging plate.

Very important part of urban transport is demand-responsive services. Taxis can be accessible, and be used by the disabled persons, but it seems not that viable option, as most of the disabled persons consider this option to be too expensive (see Figure 2). The fares are usually more than they could afford. Nevertheless this problem might be solved by subsidising limited number of trips per given time. For a while, taxi services are not subsidised in Lithuania, besides, there are only few accessible taxi vehicles. The concept of shared transport on demand ("dial-a-bus") might be option as well. There are many transport companies of Vilnius, Kaunas and other Lithuania's cities rendering passenger transport services. The most suitable for this type of service would be mini/micro bus. Those buses might be booked by phone, mobile phone services, internet and companies should be able to organise services for the requests of trips in such a way that more than one or two people are carried at the same time. This shared ride concept could reduce the cost to less than the cost of the same taxi trip. But still, it seems more like a future option rather than real intention of Lithuanian city transport companies.

Accessible information, vehicles, infrastructure and pedestrian environment are crucial towards accessible transport system. And there are lots of possibilities to develop those domains with help of ITS. Nevertheless, there are some more essential parts of accessible transport, which can be improved without ITS. As the most practical example, training of transport staff might be mentioned. The staff must be trained to better understand the needs of the disabled persons according to his/her type of disability. Other issue is role of authorities. The local, regional and national authorities have to better co-operate during the decision making processes to achieve better accessible transport system within all the levels that leads to seamless multimodal travel.

Conclusions

1. Based on survey results, wheelchair users in Vilnius still does not have accessible transport. The same is true for people with other disabilities – blind people, people with reduced coordination, strength, partially sighted and others. There is a lot for improvement, and ITS is a solution to facilitate the travelling for people with reduced mobility.
2. It is quite obvious that the use of various electronic boarding aid devices is a financial burden both for the passengers and for the transport operators. Therefore, it is important that the right choice is made after considering all the factors that may affect the safe and effective operation of the system.
3. The specific intelligent systems would promote the use of urban transport if an effective interaction amongst information area, in-vehicle and outside-the vehicle areas is ensured. Otherwise the transport will not provide a seamless process.
4. An independent boarding and alighting for the disabled persons should be the aim wherever possible. Initially it should be aimed at urban transport for which passengers do not usually reserve their seat in advance. Good accessibility usually benefits the disabled passengers because it is safer and easier to board the vehicle and benefits the operators (companies) because it can reduce the stopping-time at the stations,
5. New transport services based on demand-responsive concept could be introduced as effective way to travel for the disabled people.
6. Every passenger travelling by public transport needs information, skills and abilities to travel safely, comfortably and independently. The same is true for passengers with reduced mobility, therefore the intelligent transport systems are so beneficial, because they enable as much as possible independent, safe and comfortable travel to the disabled persons and passengers with reduced mobility.

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MODELLING DISTURBANCES IN SYSTEM TRACK – RAIL VEHICLE

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All real systems work in disturbances conditions. “Disturbances” term belongs to special category of entry values which are not known before and do not make subject to control, it means they are uncontrolled entry signals. Disturbances are an important element of systems regulation, because usually lead to unexpected effects in functioning of steered systems.

An alternative approach has been proposed in this article in disturbing signals description, related on theory of wave disturbances, which allow describing wide disturbances scale, occurred in suspensions of active vehicles.

Disturbances models based on new wave interpretation can describe wide class of real, indefinite disturbances which occur in suspensions of active vehicles.

Keywords: suspensions, active vehicles suspensions, wavy interpretation of disturbances, Laplace transform random disturbances

1. Introduction

The basic task of suspensions is guarantee expected fluidity of vehicles move by isolation body from wheels vibration caused by road unevenness. In that way bodies decide about comfort of driving for driver and passengers and also reduce dynamic loads of vehicle sets increasing their durability.

In steering theory there is known a commonly fact that all real systems work in disturbances conditions. “Disturbances” term belongs to special category of entry values which are not known before and do not make subject to control, it means they are uncontrolled entry signals.

Disturbances are an important element of systems regulation, because usually lead to unexpected effects in functioning of steered systems. The typical disturbances examples which occur in vehicle driving are: gusts of wind and other aerodynamic forces which influence on vehicle, friction and neutrals in suspension system, unevenness of road pavement, moving centre of gravity and another undefined effects of displacements in mechanical sets of vehicles.

In science researches, run from the end of 70-ties in the last century, related to active bodies in vehicles deterministic or random interpretation of disturbing signals is accepted. If first of mentioned approach presents too simple meaning of disturbances nature then second complicate too much their description.

Statistics properties of disturbances such as average value, variation, spectral density and other supported on average are long term values. Meanwhile driver driving vehicle on chosen part of road by changing wind follow the current behave.

Effective steering in case of disturbances requires current information about their functioning. Statistic information supported on long-term observations doesn’t meet current information demands and becomes in steering in real time totally useless.

An alternative approach proposed in disturbing signals description, related on theory of wave disturbances, which allow describing wide disturbances scale, occurred in suspensions of active vehicles is presented in the lecture.

2. Wavy Interpretation of Disturbances in active vehicles suspensions

Disturbances which characterize wavy structure can be mathematically described by half-deterministic analytical dependences in the following way [1]:

$$w(t) = W\lfloor f_1(t), f_2(t), ..., f_M(t);.c_1..,c_L\rfloor, \tag{1}$$

where $f_i\ (t), i = 1,2,..,M$ (M-finite value) – known time functions,

c_k, $k=1,...,L$ – unknown parameters, which can stepped change in a partly solid way their meanings. Mathematical models (1) type will be called as wave interpretation of disturbances $w(t)$.

Linear description (1) can be considered as interpretation $w(t)$ in functional area, where function set $\{f_i(t),...,f_M(t)\}$ is a base, and c_i – is partly solid weight factor. In other words disturbances $w(t)$ present linear weight combination of known basic functions $f_i(t$ and unknown weight factors c_i, which randomly in periodically-solid way change their meanings [3].

An example illustration of equation (1) is presented in Figure 1.

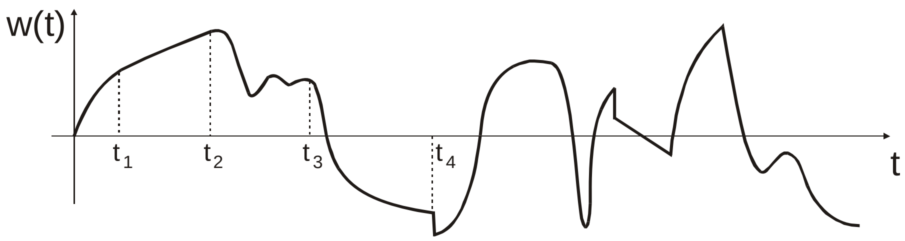

Figure 1. Wavy structure disturbances

Proposed interpretation of disturbances $w(t)$ definitely differs from their traditional random treatment. Especially information range contented in equation (1) is qualitatively different from information contented in traditional statistic ideas, such as average value, variation, spectral density and others. Senses of factors ci in equation (1) are totally unknown (with the exception that they change in periodically-solid way). Wavy interpretation doesn't operate traditional statistical features and doesn't describe them.

So interpretation (1) fills in "informative vacuum" in description of disturbances which occur in suspensions of active vehicles.

Especially equation (1) allows to describing wide range of possible wavy forms, which contain any unknown realization of disturbances $w(t)$ in moment t. Besides, each separate realization $w(t)$ in wavy interpretation can possess "its own" set of statistic features, thanks to which it can be used also to describe non-ergodic disturbing functions $w(t)$ especially when each realization $w(t)$ is a constant random value.

3. Models of wavy disturbances

Pointing out system of basic functions $\{f_i(t)\}$, is a first step in using wavy interpretation of disturbances as an instrument of regulation system. It can be done on the basis of visual and mathematical analysis of experimental recordings w(t) or by analysis of dynamic characteristics of physical process which generate w(t).

In the second step proper "state model" for equation (1) should be specified. The model is a differential equation met by function (1). In other words equation (1) should be considered as known "general solution" of looked for differential equation. Let's suppose that each chosen function $f_i(t)$ has Laplace transform $f_i(s)$, in the following way:

$$f_i(s) = \frac{P_{m_i}(s)}{Q_{n_i}(s)}, \tag{2}$$

where: $\mathrm{P}_{\mathrm{m_i}}(\mathrm{s}), \mathrm{Q}_{\mathrm{n_i}}(\mathrm{s})$ – polynomials adequately m and n grade $m_i \le n_i$. If c_i temporarily suppose as permanent values then the transformation of Laplace's equation (2) is the following:

$$w(s) = c_1 f_1(s) + c_2 f_2(s) + ... + c_M f_M(s) = \sum_1^M c_i \frac{P_{m_i}(s)}{Q_{n_i}(s)}, \tag{3}$$

finally:

$$w(s) = \frac{P(s)}{Q(s)}, \tag{4}$$

where polynomial of numerator $P(s)$ includes factors c_i, and polynomial of denominator $Q(s)$ is the smallest general denominator in set of denominators polynomials $\{Q_{n_1}(s), Q_{n_2}(s), \dots, Q_{n_M}(s)\}$ of equation (3). Such interpretation guarantee minimal size of final model of state $w(t)$, which has the essentials of meaning from point of view of costs and apparatus complexity. So let's suppose that denominator polynomial $Q(s)$ in equation (4) is following:

$$Q(s) = s^{\rho} + q_{\rho} s^{\rho-1} + q_{\rho-1} s^{\rho-2} + \dots + q_2 s + q_1, \tag{5}$$

where $\rho \leq \sum_1^M n_i$. From equation (4) comes that disturbances $w(t)$ can be treated as „initial variable" of fictional linear dynamical system of operational transmission:

$$G(s) = \frac{1}{Q(s)}, \tag{6}$$

by initial conditions $\{w(0), \dot{w}(0), \ddot{w}(0), \dots\}$. then disturbances (1) with taking dependences under consideration (3)-(5), meet the following homogeneous linear differential equation with constant parameters:

$$\frac{d^{\rho} w}{dt^{\rho}} + q_{\rho} \frac{d^{\rho-1} w}{dt^{\rho-1}} + q_{\rho-1} \frac{d^{\rho-2} w}{dt^{\rho-2}} + \dots + q_2 \frac{dw}{dt} + q_1 w = 0, \tag{7}$$

where factors q_i, $i=1,2,\dots,\rho$, are known, because don't depend on c_i and they are determined by system of basic functions $\{f_i(t)\}$, which are taken for given.

To take into consideration stepped factors changes ci in equation (7) we add to it external forced function $\omega(t)$, which is a progression of unknown, randomly appear pulse functions with randomly intensity (single, double, triple, etc. kind of Dirac's function).

So model of state $w(t)$ finally takes the form:

$$\frac{d^{\rho} w}{dt^{\rho}} + q_{\rho} \frac{d^{\rho-1} w}{dt^{\rho-1}} + q_{\rho-1} \frac{d^{\rho-2} w}{dt^{\rho-2}} + \dots + q_2 \frac{dw}{dt} + q_1 w = \omega(t). \tag{8}$$

It is important that pulse forced function $\omega(t)$, is unknown and introduced to model of state (8) just only in symbolic way with the purpose to mathematical description of steps ci in equation (1). Beside moments of appearance adjacent pulse functions are separated by minimal positive range $\mu > 0$.

So if base functions fi(t) in equation (1) has Laplace transform in kind (2) then with the purpose of finding state model for equation (1) it is necessary to define factors $\{q1, q2, \dots, q\rho\}$ from equations (1) and (5), and next use general state model (8).

Differential equation of the order of ρ (8) can be presented in the form of system of differential equations of the order of first. For example equation (8) can be written down equivalently in form of "totally observed" known canonic form:

$$\begin{aligned}
&w = z_1, \\
&\dot{z}_1 = z_2 + \sigma_1(t), \\
&\dot{z}_2 = z_3 + \sigma_2(t), \\
&\quad\vdots \\
&\dot{z}_{\rho-1} = z_{\rho} + \sigma_{\rho-1}(t), \\
&z_{\rho} = -q_1 z_1 - q_2 z_2 - \dots - q_{\rho} z_{\rho} + \sigma_{\rho}(t)
\end{aligned} \tag{9}$$

where symbolic activity $\omega(t)$ in equation (8) is replaced in equation (9) by functions $\sigma_i(t)$, $i=1,2,...,\rho$, which are progressions of unknown, random Dirac's functions, and point means an operator d/dt.

In general case it should be expected that differential equation (8) or system of differential equations (9) will contain variable factors q_i and/or nonlinear elements below $w,dw/dt$ etc. So searched "state model" for disturbances $w(t)$, which have wave structure, can be presented in the form of one differential equation of the high order:

$$\frac{d^{\rho} w}{dt^{\rho}} + f(w, \frac{dw}{dt}, ..., \frac{d^{\rho-1} w}{dt^{\rho-1}}, t) = \omega(t), \tag{10}$$

or in form of system of equations of the first order:

$$\begin{aligned} &\omega = W(z,t), \\ &\dot{z} = Z(z,t) + \sigma(t); \end{aligned} \qquad z = (z_1, z_2, ...z_\rho). \tag{11}$$

Let's consider that model (11) has the advantage over model (10) because it uses methods of state variables. If $w(t)$ is a multi-dimension disturbance which contains p components $w = (w_1, w_2, ..., w_p)$, then state model should be determined for each independent component $w_i(t)$.

4. Examples of State Models for Real Disturbances in Suspensions of Active Vehicles

State models expressed by equations (10) and (11) for real disturbances, occurred at least in short time intervals in suspensions of active vehicles, can be determined on base recordings of experimental oscilogram presented in Figure 2.

Example 1. In case shown in Figure 2a disturbances meet the following differential equation:

$$\frac{dw}{dt} = 0 \tag{12}$$

c in that case is a constant.

To take into consideration unknown random, stepped changes c, it should added to equation (12) the element σ(t), which composed of unknown progression of Dirac's function. State model of disturbances $w(t)$, presented in Figure 2a has finally the following form:

$$\frac{dw}{dt} = \sigma(t). \tag{13}$$

Example 2. Disturbances presented in Figure 2b described by equation $w(t) = c_1 + c_2 t$, which meet the following differential equation of second order:

$$\frac{d^2 w}{dt^2} = \omega(t), \tag{14}$$

where $\omega(t)$ means unknown progression of random single and double impulse of randomly intensity. Equivalent model in system form (9) is the following:

$$w(t) = (1,0)\binom{z_1}{z_2} \tag{15}$$

$$\dot{z}_1 = z_2 + \sigma_1(t), \qquad \dot{z}_2 = 0 + \sigma_2(t), \tag{16}$$

Example 3. Disturbances $w(t)$, presented in Figure 2c. of Laplace transform:

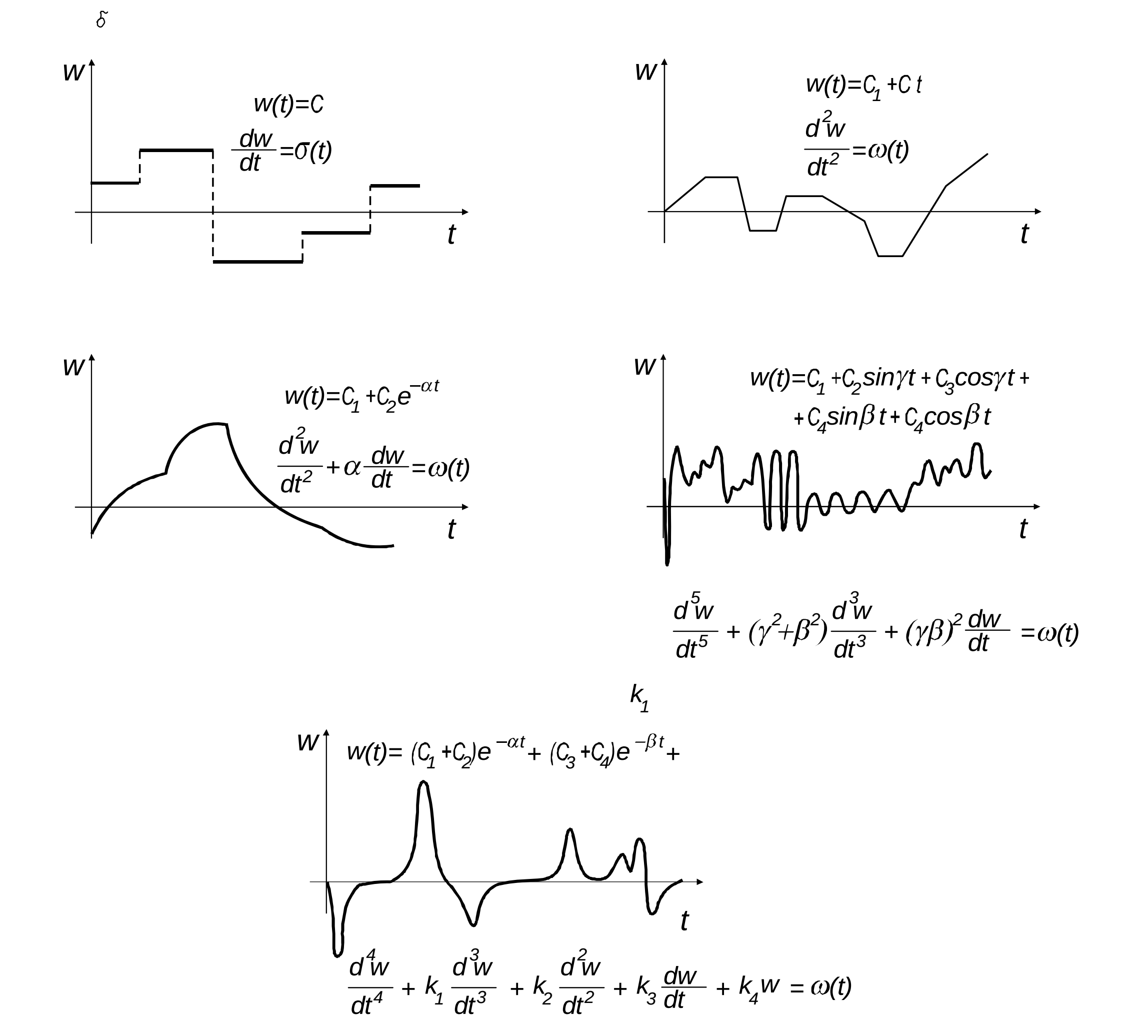

Figure 2. Disturbances of wavy structure in suspensions of active vehicles

$$w(s) = c_1\left(\frac{1}{s}\right) + c_2\left(\frac{1}{s+\alpha}\right). \tag{17}$$

can be presented in equation form (4) as follows:

$$w(s) = \frac{\left[c_1(s+\alpha) + c_2 s\right]}{s(s+\alpha)}. \tag{18}$$

In that case $Q(s) = s^2 + \alpha s$, and from equations (5) and (8) it follows that $w(t)$ meet the following differential equation of second order:

$$\frac{d^2 w}{dt^2} + \alpha \frac{dw}{dt} = \omega(t). \tag{19}$$

Equivalent state model has the form:

$$w = (1,0)\begin{pmatrix} z_1 \\ z_2 \end{pmatrix} \tag{20}$$

$$\dot{z}_1 = z_2 + \sigma_1(t), \qquad \dot{z}_2 = \alpha z_2 + \sigma_2(t), \tag{21}$$

Example 4. Disturbances *w(t)* in kind of small waves presented in Figure 2d has the following Laplace transform:

$$w(s)=\frac{P(s)}{s\left(s^2+\gamma^2\right)\left(s^2+\beta^2\right)}. \tag{22}$$

So according to equations (5)-(8), *w(t)* meets the following differential equation of fifth order:

$$\frac{d^5w}{dt^5}+\left(\gamma^2+\beta^2\right)\frac{d^3w}{dt^3}+(\gamma\beta)^2\frac{dw}{dt}=\omega(t). \tag{23}$$

Equivalent presenting the equation (23) has a form:

$$w(t)=(1,0,0,0,0)\begin{pmatrix} z_1 \\ z_2 \\ z_3 \\ z_4 \\ z_5 \end{pmatrix} \tag{24}$$

$$\begin{aligned} &\dot z_1=z_2+\sigma_1(t), \qquad \dot z_2=z_3+\sigma_2(t),\\ &\dot z_3=z_4+\sigma_3(t), \qquad \dot z_4=z_5+\sigma_4(t),\\ &\dot z_5=-(\gamma\beta)^2z_2-\left(\gamma^2+\beta^2\right)z_4+\sigma_5(t), \end{aligned} \tag{25}$$

Example 5. Impulse type disturbances presented in Figure 2e of Laplace transform :

$$w(s)=\frac{P(s)}{\left(s^4+k_1s^3+k_2s^2+k_3s+k_4\right)} \tag{26}$$

where k_i – are functions of two known parameters α i β, meet the following differential equation:

$$\frac{d^4w}{dt^4}+k_1\frac{d^3w}{dt^3}+k_2\frac{d^2w}{dt^2}+k_3\frac{dw}{dt}+k_4w=\omega(t) \tag{27}$$

or

$$w(t)=(1,0,0,0)\begin{pmatrix} z_1 \\ z_2 \\ z_3 \\ z_4 \end{pmatrix}, \tag{28}$$

$$\begin{aligned} &\dot z_1=z_2+\sigma_1(t),\\ &\dot z_2=z_3+\sigma_2(t),\\ &\dot z_3=z_4+\sigma_3(t),\\ &\dot z_4=-k_4z_1-k_3z_2-k_2z_3-k_1z_4+\sigma_4(t) \end{aligned} \tag{29}$$

where k_i are known factors, depended on parameters α i β.

Conclusions

Achievements of microprocessor technology in the space of ten years gave another dimension of digital steering systems. Contemporary steering theory cannot omit problematic disturbances which occur in real complex multidimensional systems.

Counteracting to disturbances is old and important task in designing closed steering systems. Traditional methods of regulation base on deterministic interpretation of disturbances or presenting them by models of stochastic processes. First approach presents too simplified understanding of real phenomenon nature, while second reflects excessive pessimism and provides to complicated description of real disturbances.

This lecture presents alternative methods of indefinite disturbances description, more exact than deterministic approach and not so complicated as models of stochastic processes. Disturbances models based on new wave interpretation (fig.3) can describe wide class of real, indefinite disturbances which occur in suspensions of active vehicles.

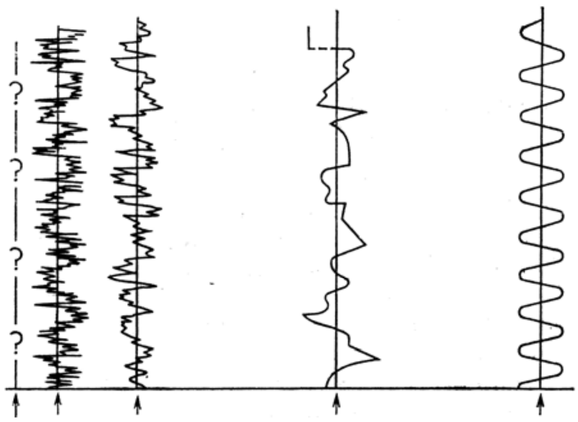

Figure 3. Place of wavy structure in spectrum of infinity

Using a wave method of disturbances modelling and contemporary methods of state variables can be built new effective class of closed steering systems called as regulators which adapt to disturbances; those disturbances can:

a) absorb external disturbances in automatic way,
b) minimize influence of external disturbances in real time,
c) use in optimal way external disturbances for controlling system of vehicle suspension.

Using active systems of vibro-insulation controlled by regulators which adapt to disturbances allow not only to monitoring vehicles dynamics in real time but also improve driving comfort.

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METHODOLOGY DEVELOPMENT AND ITS IMPLEMENTATION IN ANALYTICAL SYSTEM FOR TRANSPORT AND LOGISTICS EDUCATIONAL PROGRAMS

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The purpose of the paper is to present the methodology and its implementation results in the field of statistical research of TTI study process trends by use of analytical system.

The actual analytical system (AS TTI) for data maintenance and analysis was created at Transport and Telecommunication Institute (TTI) based on the OLAP principle [1]. The paper represents experimental results of the analytical system implementation for statistical research of study subjects' interconnections for transport and logistics educational programs.

Advanced technology allows users to perform a multidimensional data analysis for decision making purposes. The system uses independent Data Marts, which are constructed basing on information delivered from actual TTI Information System (OLTP).

The paper emphasizes one of the analytical tasks of study processes management at the university, which has been solved using the AS TTI Data Marts "Analysis of examinations marks for study subjects at different study programs".

As the example of the suggested methodology some correlation coefficients were calculated and analyzed to characterize examination marks interdependency between study subjects for several educational programs in the transport and logistics area. As the result factually existing study subject interconnection was recognized on the base of correlation analyses. The analytical methodology implemented in the AS TTI was recommended as an eventual tool for investigation of study subjects' interconnection, aimed to improve the quality of educational programs.

Keywords: the University Analytical System, OLAP-technology and Data Marts

1. Introduction

The research in the field of education services quality control was launched at TTI in 1998 [1]. This work has been conducted within the frames of several projects orientated to the development of the Baltic Region [2].

The updated analytical system (AS TTI) for data maintenance and analysis was created on the OLAP principle. The paper represents the results of the AS TTI by research of TTI study process trends.

The technology used by AS TTI allows performing a multidimensional data analysis for decision making purposes. The system applies independent Data Marts, which were constructed by use of information from actual TTI Information System (OLTP) by data filtering and clearing from the whole period of its operation.

The OLAP-technologies would help to improve the currently used TTI decision support computer system making use of the existing information systems of the University.

Undertaken research and interrogation of top managers of the University have defined the following possible task of AS TTI: Analysis of examinations marks for study subjects at different study programs in the context of years of enrolment, faculties, study types and study languages.

2. TTI Information System Overview

The TTI information system (IS), based on OLTP technology is successfully supporting multiple information processes at the university. The system is aimed to registration of all aspects of the institute's study activity, as well as the management of its intellectual, material and financial resources. Integral part of the system is e-learning [3].

It therefore includes more than ten subsystems each directed to the solution of a certain class of tasks, described in [6].

Existing IS has been implemented by the employees of the Information Technologies Department of the university with the use of MySQL DB and WEB-server Apach.

Modern network technology application and common database, within the implementation of computer-aided information system of the university, permits to install a simple mechanism of information integration into common information resource and provide opportunity to share information with many users (university administration, students, lecturers etc.). Thus the higher level of data integrity may be achieved as well as conditions will appear to create successful functioning of common information environment of the university.

Access to time-schedule and other information required by a large number of users is achieved through WEB-interface for any user at any time and at any point (if the user has been properly authorized).

3. TTI Analytical System AS TTI

AS TTI architecture was created to support the following activities.

Initial data for analysis were selected from the existing IS, preliminary tested and filtered by some features. The data represent value of indices, which characterize study process at certain study program during the whole period of IS functioning.

Data were gathered and stored in the data warehouse created in accordance with the principles of database warehouses construction and representing the relation database organized in particular "Star" scheme. For the simplicity, it was decided to fix several data marts instead of one data warehouse, containing data of specific direction of analysis tasks.

The advantages of the suggested data storage model in the form of data warehouses are follows:

- data support historical demands, analysis of tendencies and strategic decision-making;
- the model is orientated to the subject area;
- common coordinated definition of data and mutual data domains at the enterprise level;
- controlled denormalization for the efficient data extraction;
- contains data with full or partial history of changes;
- contains temporal data;
- contains internal data of the enterprise, as well as useful external data helping to conduct analysis of tendencies, for example, demographic and economic data.

The main table of warehouse or mart (table of facts) contains numerical values of indices that serve for gathering information. Table of facts and tables of measurements are connected in accordance to the "Star" topology.

The "Star" topology has been chosen from two possible data warehouse topologies – "Star" and "Snowflake" – taking into account its simplicity and speed of operation.

The Star model of database has the following structure. The essential information on students' marks is assembled in the table of facts. The tables of measurements consist of more detailed information about study programs, periods of studying, types of program, study languages, study types, faculties, courses etc.

The replication of warehouse once per term is assumed, after the data about progress per term is entered in IS, and rates are verified and calculated.

User obtains opportunity of remote access to data stored in the system with the help of customer application and gets the opportunity to form requests, generate reports, and obtain arbitrary sub-sets of data for further analysis.

In the considered Analytical System several Microsoft SQL Server 2005 applications were used:

- Database Engine for creating and storage of databases, construction of data warehouse (mart);
- Data Transformation Services for import of necessary part of data from OLTP-system;
- Analysis of Services for construction of OLAP-cube and OLAP-system building.

At the final step of analyses MS Excel application was used for data visualization and charts and graphs construction.

4. Suggested Methodology Description

Results of AS TTI implementation were based on our previous research, published in [6]. To perform the research new data marts and visualization were created and statistical data updated.

To verify application of the suggested method of analytical tasks solution by DSS with the use of new structure of the stored data, subject orientated marts of historical data (data marts) were created in connection with common organizational process.

Analysis of examinations marks for study subjects at different study programs in the context of years of enrolment, faculties, study types and study languages were considered as the research goal.

The following procedure for the mentioned analytical task solution was offered (see Fig.1):

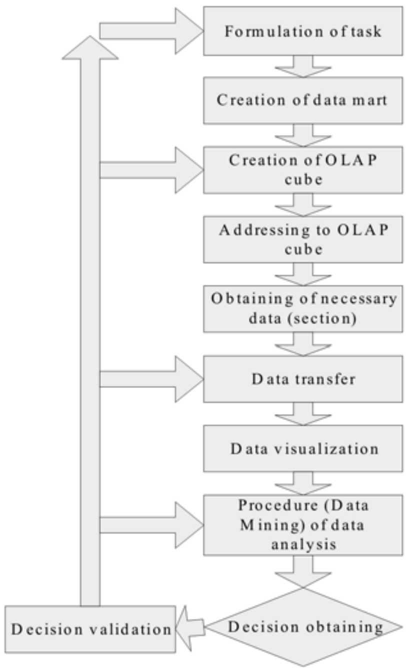

Fig. 1. The offered procedure for analytical task

Suggested methodology is based on a conclusion about apparent dependency between students' marks from different study subject. It is widely accepted by educators that there are study subject chains (sets of interrelated subjects), e.g. in mathematics or economics area. We allow existence of interrelation (correlation) between students' examination marks as well as between study subject content. For example, good students' knowledge (and marks) in "Higher Mathematics" leads to high marks (and good knowledge) in study subject "Optimization Theories and Methods".

On the base of this assumption a kind of experiment of students' marks correlation research was performed at transport and logistics educational programs. The research was supported by existing statistical tools build in MS SQL Server 2005 Analysis Services.

5. The Example of Analysis

Required information was collected for two programs from the field of transport and economics thought at TTI during 2005-2008.

The first program is "Bachelor of Social Sciences in Management Science", the second one "Transport Management" professional study program.

Data Mart was build on the data from IS TTI for following dimensions: program type, instruction language, enrollment year and educational program type (full-time, part-time).

An attempt was made to find a correlation between students' marks for couples of study subjects from a common area. For example, "Higher Mathematics" and "Optimization Theories and Methods" or "Statistics" and "Optimization Theories and Methods", "Optimization Theories and Methods" and Bachelor or Diploma theses defense.

As the results of this research a kind of a weak correlation was determined. Calculated correlations coefficients were in the range from 0.5 to 0.55. For a human related statistics the correlation coefficient higher than 0.5 may be considered as meaningful because of strong influence of human behavior.

The following Figures 2, 3 present a scatterplot and chart of marks for two couples of study subjects "Higher Mathematics for the Economists" and "Optimization Theories and Methods" for Bachelor of Social Sciences in Management Science education program for 2005 year of enrollment (full-time).

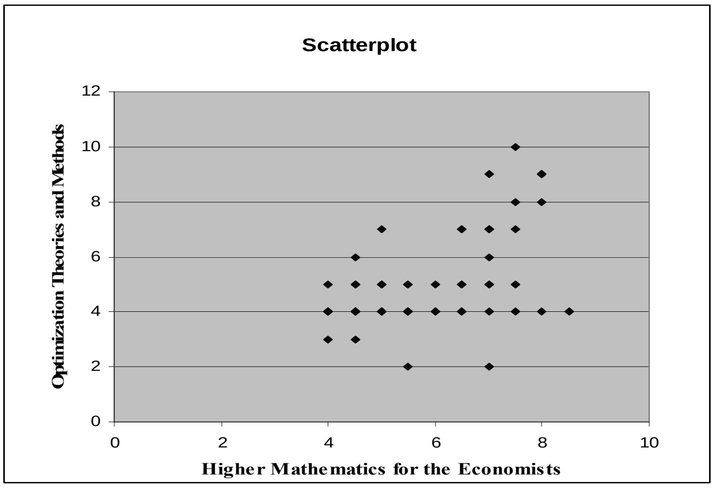

Fig. 2. The scatterplot of marks for two study subjects "Higher Mathematics for the Economists" and "Optimization Theories and Methods" ("Bachelor of Social Sciences in Management Science" education program)

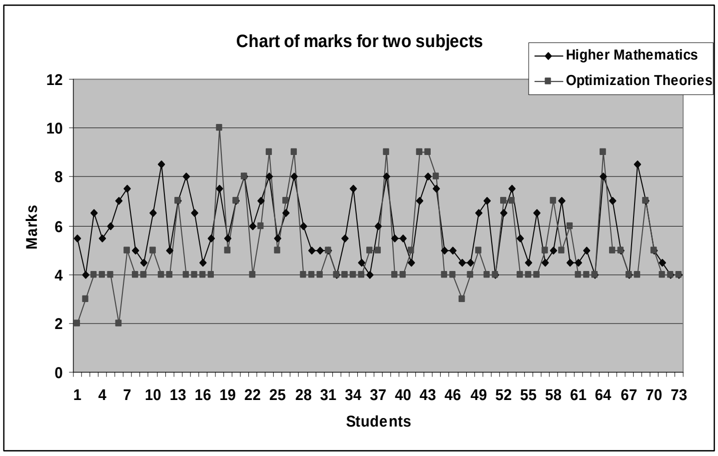

Fig. 3. The chart of marks for two study subjects "Higher Mathematics for the Economists" and "Optimization Theories and Methods" ("Bachelor of Social Sciences in Management Science" education program)

The following Figures 4, 5 present a scatterplot and chart of marks for two couples of study subjects "Statistics for the Economists" and "Optimization Theories and Methods" for Bachelor of Social Sciences in Management Science education program for 2005 year of enrollment (full-time).

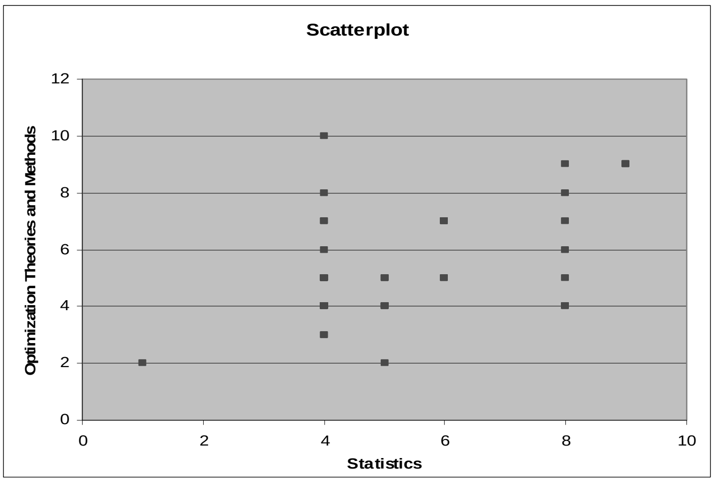

Fig. 4. The scatterplot of marks for two study subjects "Statistics" and "Optimization Theories and Methods" ("Bachelor of Social Sciences in Management Science" education program)

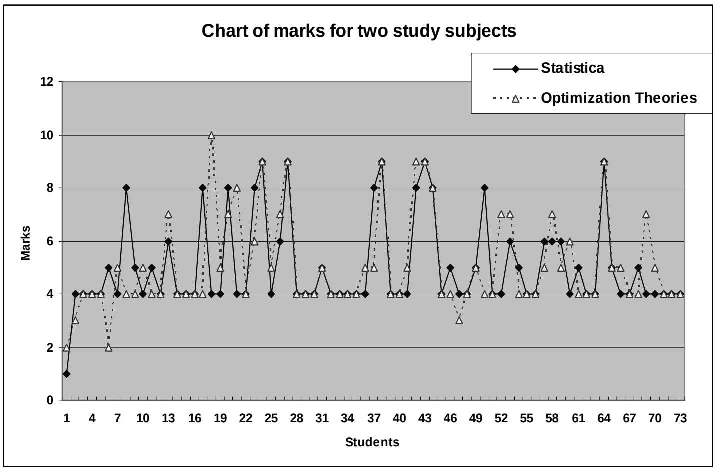

Fig. 5. The chart of marks for two study subjects "Statistics" and "Optimization Theories and Methods" ("Bachelor of Social Sciences in Management Science" education program)

The following Figures 6,7 present a scatterplot and chart of marks for two couples of study subjects "Higher Mathematics" and "Optimization Theories and Methods" for "Transport Management" Professional study program for 2006 year of enrollment (full-time).

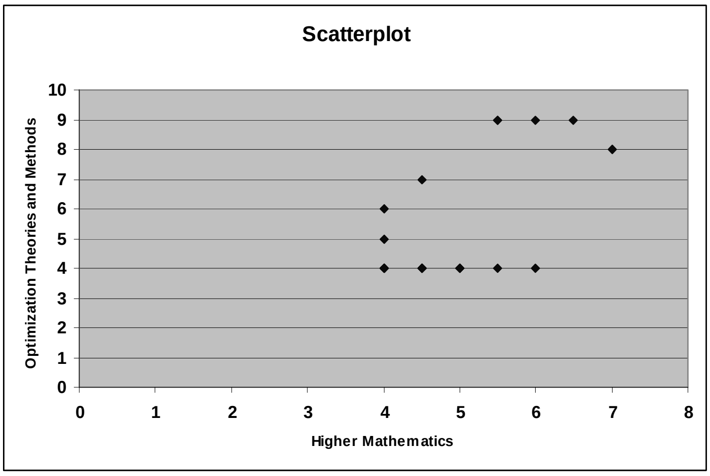

Fig. 6. The scatterplot of marks for two study subjects "Higher Mathematics" and "Optimization Theories and Methods" ("Transport Management" professional study program)

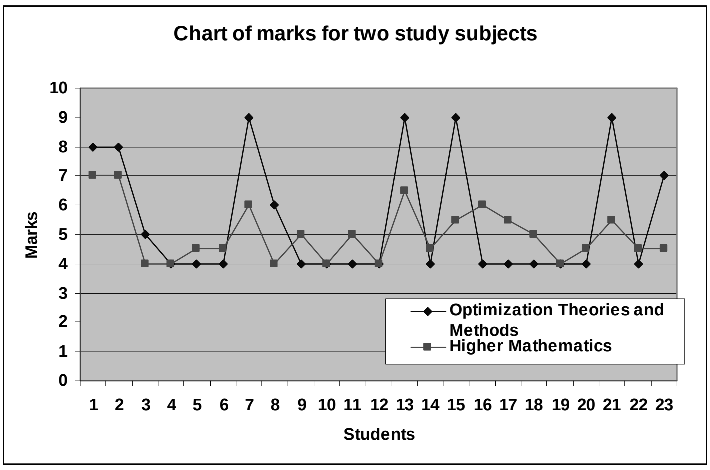

Fig. 7. The chart of marks for two study subjects "Higher Mathematics" and "Optimization Theories and Methods". Transport Management professional study program

The following Figures 8,9 present a scatterplot and chart of marks for two couples of study subjects “Statistics” and “Optimization Theories and Methods” for "Transport Management" professional study program for 2006 year of enrollment (full-time).

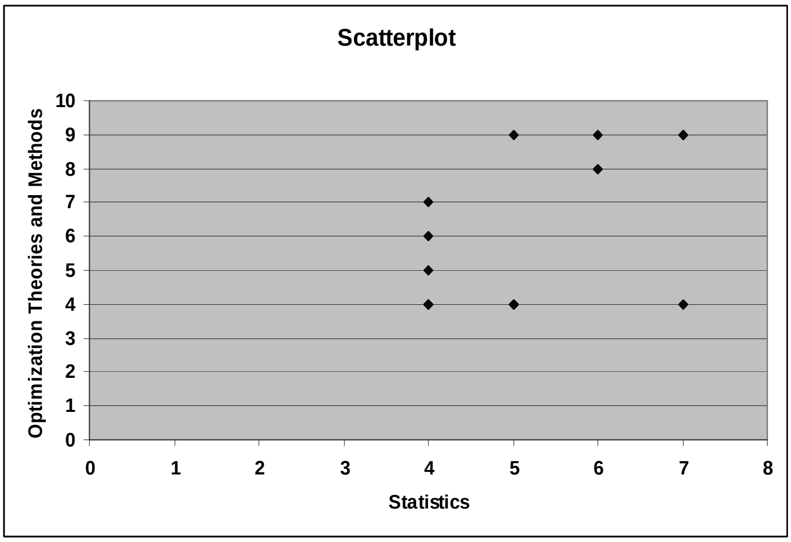

Fig. 8. The scatterplot of marks for for two study subjects “Statistics” and “Optimization Theories and Methods”. Transport Management professional study program

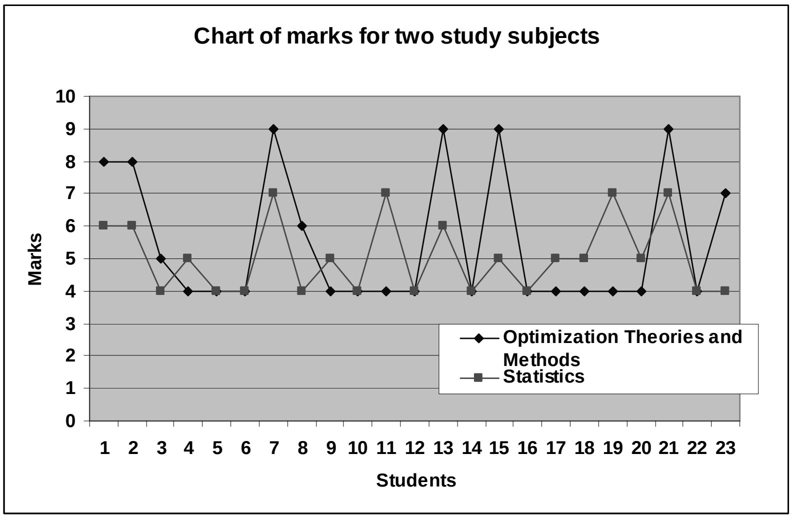

Fig. 9. The chart of marks for two study subjects “Statistics” and “Optimization Theories and Methods”. Transport Management professional study program

Unfortunately, our research didn’t give us evidences about correlation between any particular study subjects and Bachelor and Diploma Theses defense. The fact may be explained by multidisciplinary nature of Bachelor and Diploma theses, which hide the existing correlation.

Conclusion

As a result of this research it is possible to conclude the following:

1. Discussed AS TTI gives a real opportunity for study process trends research.
2. Received results can be successfully used in study process improvements.

The suggested research methodology may be used for decision support system’s design by other Universities.

The considered approach and experimental implementation of OLAP system (AS TTI) may be recommended as a tool for dependences investigation between learning outcome and student marks from different subjects.

This information allows solving following practical tasks:

1. Verification of actual study subjects' interconnection, which are declared in study plans.
2. Quantitative measurement of study content improvement results from the learning outcome point of view.

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INTELLIGENT TRANSPORT SYSTEM FOR INTRA-CITY LOGISTICS BASED ON WWW TECHNOLOGIES

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Currently in the city of Riga there are several parallel, independent of each other, networks for delivery goods. It is noteworthy that, unlike the major networks, companies doing outsourcing cannot provide the routes full load vehicles and the best routes. In the central part of the city near the same streets perform different trucks delivering goods to customers of neighbouring addresses. The movement, parking and downloading of vehicles produced during the working day and during peak hours, sometimes without taking a single lane road. This creates additional problems for urban traffic, pedestrians and the urban environment. The situation could be improved by creation of a virtual segment of intelligent transport system, planning the work of small transport companies (SME) that would work on outsourcing of logistics centres. The concept of such a system is in creation of the Internet-portal for linking customers and freight transport companies.

Keywords: intelligent transport systems, supply chains, optimisation, vehicle routing problem

1. Introduction

The situation in major cities of Europe, particularly in new EU member-countries, in the sphere of intensity of urban traffic becomes heavier every year because of the increasing number of vehicles in city streets, while maintaining an outdated infrastructure and archaic system of traffic management. For example, according to the department of traffic management (CSDD), in recent years in Riga and Riga region each year adds approximately 25-26 thousands of newly registered vehicles [1]. Moreover, there are growing volumes of freight transportation related to the development of industry and services sector. Usually the preference is given to road freight transport, which has a great degree of mobility and minimum additional links in the chain " supplier - customer".

The entry of heavy vehicles in the central part of the city (historic center) in major cities of Europe is fully or partially banned for stabilizing the tension of urban traffic. Therefore, the idea of logistics centers in the border city where a storage and transshipment of goods from large trucks (long-distance and international traffic) for delivery networks is becoming increasingly popular and other modes of transport (multimodal logistics centers) to medium and small cargo transport is performed for the delivery of goods to end-recipients. Thus, organized logistics supply network, linking between the places of storage of goods (logistics centers, warehouses of final products of the enterprises, etc.) with the clients, the customers of the goods.

At present, there are many independent supply chains of goods to supermarkets and shops located in the central part of Riga city: "Maxima", "RIMI", "Elvi", "Nelda", "RD Electronics", "Elis" and others. Some enterprises like "Dzintars", "Latvijas Balzāms", "Aldaris", "Hanzas maiznīca" also have own supply chains. The largest of them, such as "Maxima" and "RIMI", have their own distribution centers (logistic centers) located in the outskirts of the city and have the necessary space and equipment for transshipment of goods from heavy trucks on middle class freight cars (5 - 7.5 tons) to deliver goods to customers in the central part of the city.

Companies "Maxima" and "RIMI" have their own fleet to carry out the bulk of the deliveries within their supply chains. In addition, through these distribution and transportation centers the occasional delivery of goods to other customers is performed. If their own transport capacity is not powerful enough to carry out all the supplies, part of orders is transmitted to small transport enterprises (SME), specializing in the field of transport and has the fleet of necessary class of trucks (mostly, 3-5 tons of payload capacity). Such additional transport capacity "from the side" is known as "outsourcing" in the global business practice. On average, the proportion of deliveries in Riga can reach up to 20% of the total intra-transport operations through the logistics center (see Figure 1).

Thus, several parallel, independent of each other, supply chains of goods delivery operates in Riga. It is noteworthy that, unlike the major supply chains, the companies that work in outsourcing cannot provide their trips of fully loaded vehicles and with the best driving route. It is possible that in the central zone of the city practically at the same streets and at the same time some different trucks are in delivering goods to customers comply with neighboring addresses. Since the time of delivery is usually determined on the basis of personal arrangements between the carrier and the final recipient of goods, the general movement of goods vehicles in the central part of the city can be regarded as haphazard and ungovernable. On the other hand, the movement, parking and downloading of these machines is done during working hours, including peak hours of the city traffic, sometimes while taking a one-lane road. This circumstance creates additional problems for urban traffic, pedestrians and urban environment.

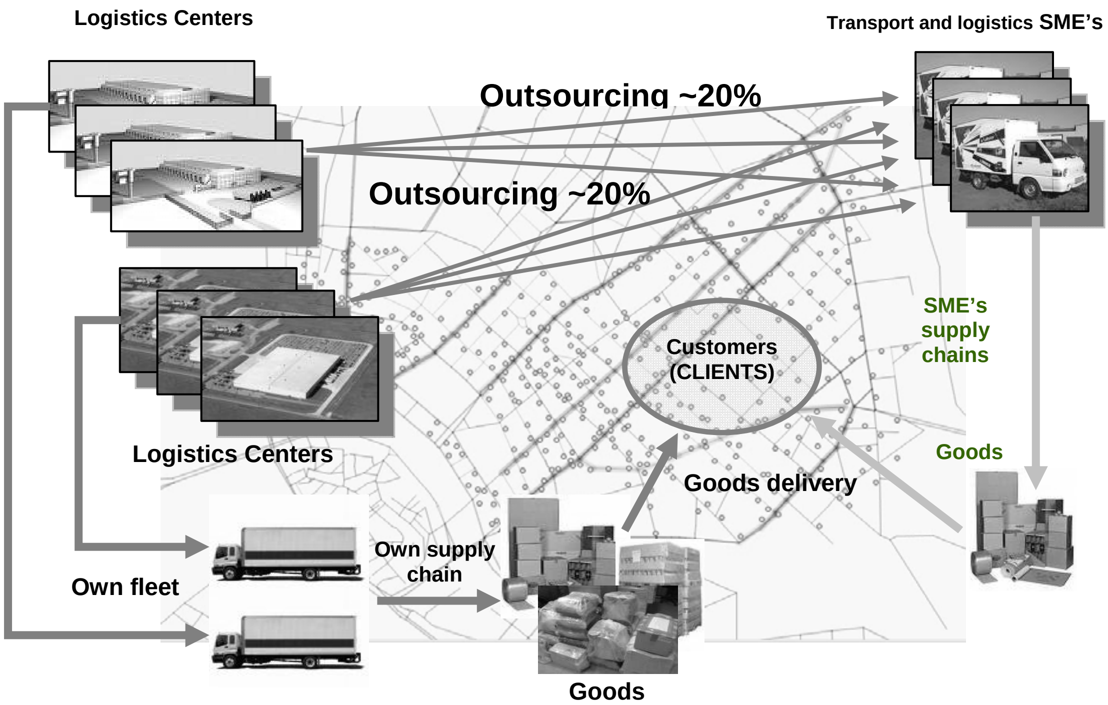

Figure 1. The scheme of inner-delivery logistics networks currently in Riga

The situation could be improved by establishment of www-portal (electronic exchange) as a virtual segment of intelligent transport system, planning the work of small transport companies (SME), that are engaged in outsourcing for logistics centers. The concept of such a system is to create sustainable and mutually beneficial cooperation between the logistics centers and companies-carriers through providing them with transport planning services.

2. The Concept of Internet Portal (Electronic Stock Exchange) for Intra-City Supply Chain of Goods

The activity of small transport companies involved in outsourcing for major logistics centers can be streamlined, if they are able to unite in a common network, managed by a joint information and analytical resources (Internet portal) and providing for it members more profitable operations, on a voluntary basis. In this way, by managing of significant part of the flow of intra-city freights delivery, one can coordinate their interests of the city, residents, the environment, for example, by using time planning to deliver cargo outside of peak hours or minimization of the freight cars in the most problematic streets in terms of traffic volume (see Figure 2).

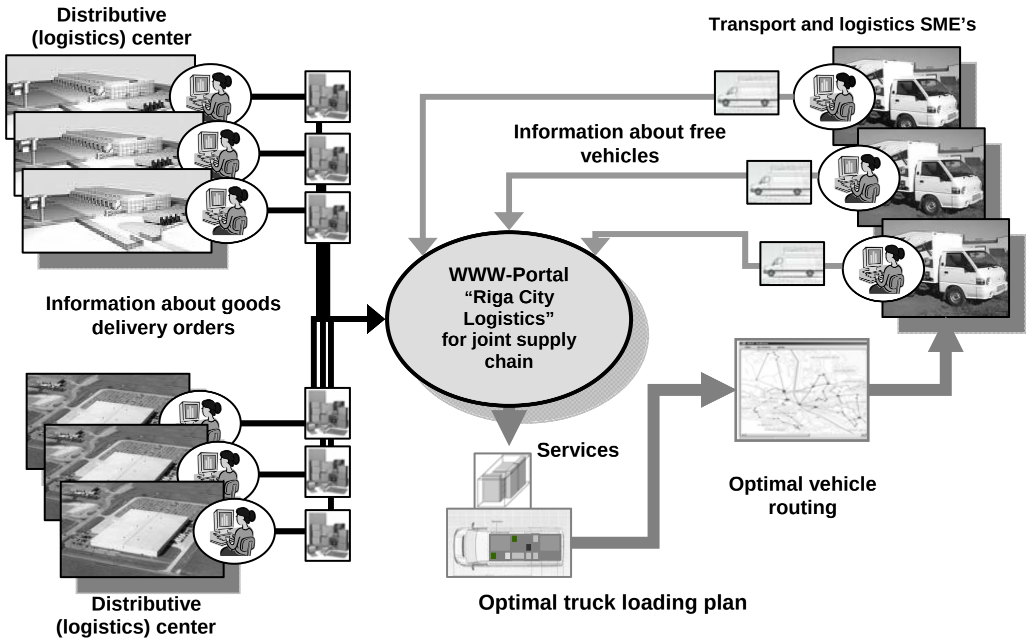

Figure 2. The conceptual scheme of organizing an Internet portal (electronic stock exchange) to manage the joint intra-city supply chain of goods

Logistics centers offer to portal the information in on-line mode about the availability of goods to be delivered to customers (address, kind of cargo, volume, the type of packaging, etc.). Transport companies provide the information about the availability of free vehicles and their characteristics (volume of cargo compartment, etc.). Then all the necessary information to determine the minimum required number of vehicles to ensure the supply of goods for a certain period of operational planning (for example, on the following day) meets in the information service portal (see Figure 3).

Figure 3. The interface prototype of Internet portal "Riga City Logistics" (electronic stock exchange) to manage the joint intra-city supply chain

Combining the volume of shipments for all available orders can maximize the use of vehicles for carriers (a car full load and an optimal time or distance of traffic route). To do this, optimization (heuristic and combined) algorithms can be used [2-6]. The existence of a unified information system data on orders for transportation of various goods and information about free vehicles effectively meet the challenge of planning the optimal load vehicles and the task of planning the best routes in the face of external constraints (time, travel bans on certain streets at certain times and so on) [5-6]. The result of optimizing software of www-portal can be operational plans and schemes of allocated vehicles' routes (the next day routes) that meet the above criteria. An example of such a route is shown in Figure 7.

3. Functional and Informational Model of "City Logistics" Internet-Portal

As presented above, the aim of a portal "Riga City Logistics" is a creation of the joint electronic communication and collaboration space of three types of market players: transport companies, logistics centers, and retailers.

The concept provides that the portal software will include *planning kernel* - a specialized software module that is capable of applications received under the plan quickly transport routes for the entire system, minimizing the overall cost of the system as a whole. The algorithms used to build this kernel-based transport system, are oriented to the achievement of the condition, known as the "social equilibrium" or Pareto optimum [7]. With their use, routes are planned so that the total costs throughout the system earn less than if each player was forced to choose its own best strategy itself (*synergy* effect).

The main interface is a Web-portal site through which authorized visitors can keep applications for transportation, offer vehicles for transportation to receive assignments, monitor the status of orders and stuff. All these actions are recorded in a single database portal.

The draft provides for the integration of customer information systems with the database via the portal XML Web-services, which are an alternative business-to-business portal interface. Figure 4 shows the general scheme of interaction between the components of the portal and the external environment.

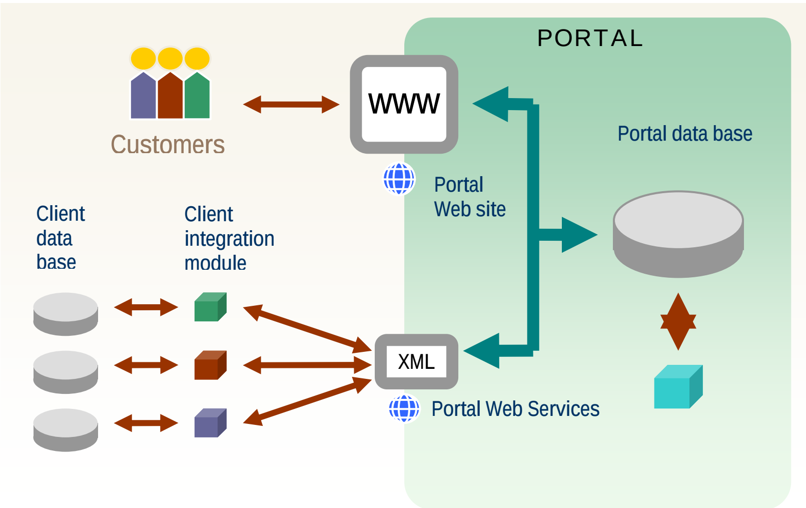

Figure 4. The scheme of interaction between the portal components and the external environment

Then the operation provides a portal in terms of its users, their roles and functions. It also provides the main scenario; use the portal (financial relations aspect of the players at this stage is not considered).

3.1. Users of the portal, their rights and duties

The draft scheme of the portal provides for a minimum five categories of users:

- *Representatives of logistics centres;*
- *Representatives of transport companies;*
- *Representatives of shops (trade centres);*
- *Operators;*
- *Administrator.*

In Figure 5 it represents a hierarchical classification of users, collecting all users listed above in two categories:

- *Clients;*
- *Technical staff.*

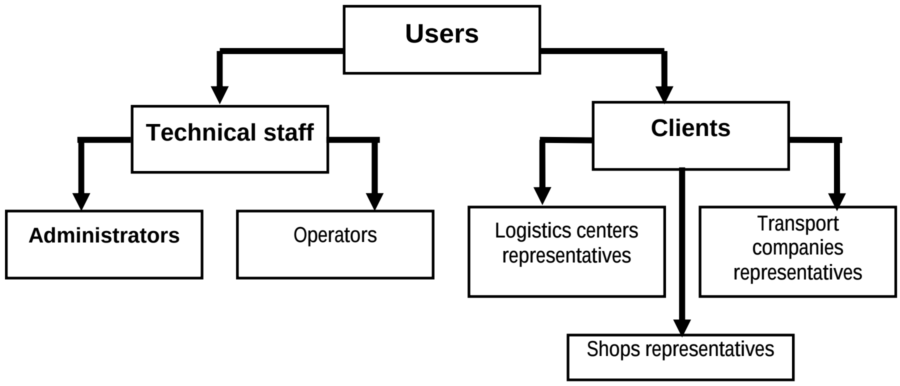

Figure 5. Users classification

All of the above categories of users are roles. This means that in principle the same individual could combine several roles.

Formally, the portal is designed for cooperation between the enterprises, but in fact the access to portal is personalized. This means that each user is identified by the system individually and he shall be individually responsible for his acts committed while using the portal.

3.2. Portal's functional map

The functional map of the portal is presented in Figure 6. It schematically displays the screen forms (pages), available for different types of the users, as well as navigational links between them.

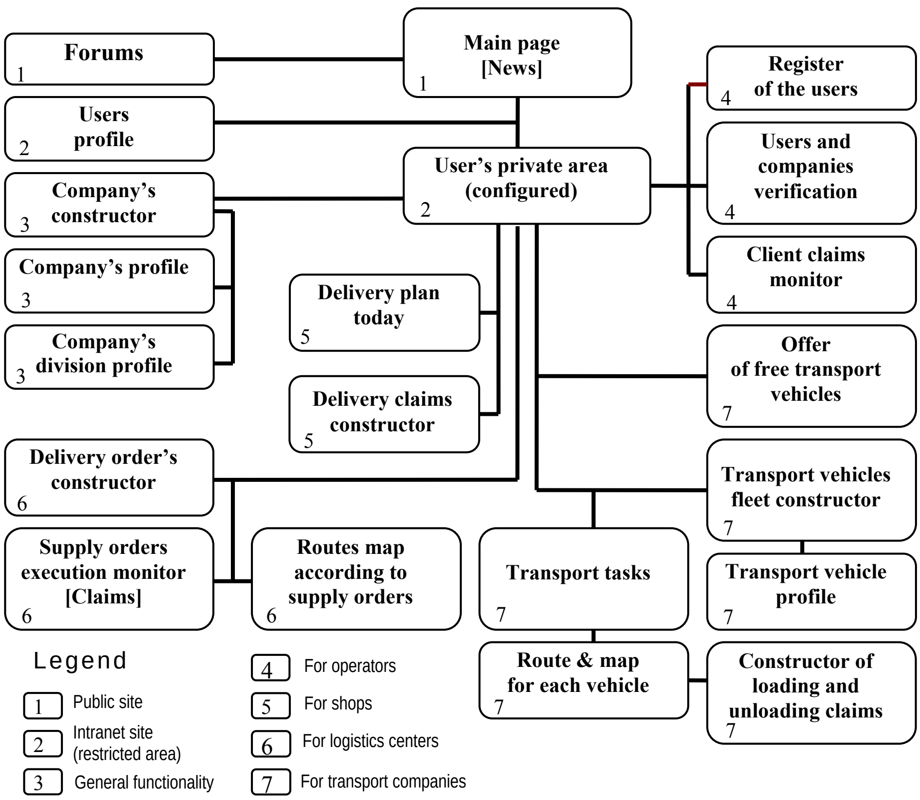

Figure 6. Portal's functional map

3.3. The mechanism of registration of users and companies

Each user, regardless of its provisions in the system, should provide at least the following characteristics (elements of the user profile):

- *Name;*
- *Surname;*
- *Personal code;*
- *E-mail;*
- *Telephone.*

The system in this case also proposes to select a unique user name and password, which together with the date of registration are saved as a user's options. The remaining elements of the user's profile are already dependent on user's role.

The status

One of the possible statuses is being defined for a user account:

- *Unclear* - *the user can only enter his data,*
- *Guest (training)* - *the user can do almost everything, but without fixing,*
- *Working (read-only)* - *the user can browse working data,*
- *Working full power* - *the user can pass core activities,*
- *Blocked* - *the user can do nothing.*

The system allows users to register themselves on the portal site, specifying the minimum elements of mentioned profile, as well as passing the test CAPTCHA (preventing the automatic registration). In this case the user has obtained an account with the status "Unclear". Such an account has a minimum of rights, while the user is seen as a client: he is suggested to choose by whom it considers itself: *the representative of ...*

- *... Logistics center,*
- *... Transport company,*
- *... Shop (the recipient of goods).*

The user can also either create a profile of the company he works in or seek to connect to the company already registered in the system. Profile is created in the mode of company constructor and includes the following attributes:

- *Title,*
- *Registration Number,*
- *Legal notices,*
- *Bank account,*
- *The official telephone and fax,*
- *Responsible person.*

For one company one can also create multiple units of the physical address where the units are located. Among the units there are:

- *Logistic Centers (point of embarkation),*
- *Shops (the point of discharge),*
- *Transport fleet.*

For each unit it must be signed:

- *Conditional title,*
- *Physical address,*
- *Contact person, who is responsible for this unit.*

A person, who requested the inclusion of firms in the database portal, automatically becomes a responsible and a contact person (i.e. the user). The user with the status "unclear" cannot do anything more. It is necessary that someone from administrators or operators would change his status to continue normal work in the system.

The administrator

Initially in the system there is only one user with pre-established properties and rights - *administrator*, he is a super-user. The administrator has all the available rights, including the right to register new users and give them (or take off) the rights, which deems fit. Including them an administrator can give the user administrative rights. The support of technical integrity of the system, as well as registration of *operators*, is the main responsibility of the administrator.

The operator

The operator's account can be created only by administrator and handed over personally (or through the privacy channel) to the appropriate user. The main responsibility of the operators is the verification of information provided by customers themselves (see above), as well as registration of claims and fulfilling appropriate actions.

The operator is responsible for regularly reviewing the list of user accounts with the status of "unclear" and implementation the *off-line* verification of information about the user and firm. On the base of the results of verification the operator changes the account status. If the result is negative, the verified account can be blocked.

In addition, the operator can change the status of the company based on the history of interaction with the company. Once the operator has verified the user and data of the company, the user officially becomes the representative of any unit of any company. The user reserves the right to update his profile and the profile of his company, but in case of any modifications he must undergo re-verification. Therefore, before editing profile, the user is warned about this.

The representative of transport company

The representative of transport companies performs the following steps:

- Fill and maintain relevant information on their fleet (must be registered on all vehicles that could potentially participate in the process of transport);
- Daily providing information on the availability of vehicles for tomorrow (accurate lead time to plan is to be determined by experience);
- Daily from morning (exact time is to be determined by experience) receive job to the transportation of goods, which are obliged to refer to drivers for fulfillment;
- Timely report the failure of transportation task (force major, etc.).

Profile of vehicle, which should be filled by the representative of the transport company, is as follows:

- *The internal accounting identifier (can be generated by the system or introduced for easer identification of the vehicle);*
- *State number;*
- *Carrying capacity (automatically determines the type of vehicle);*
- *Type of the vehicle (Passenger, minibus, truck);*
- *The height, length and width of the cargo compartment;*
- *The company - owner.*

The information about free vehicles must be stored every day by an authorized representative of the transport company manually or exported from the schedule employment vehicles from the transport company's information system (if it exists in the company).

Every morning for each offered free transport vehicle, the job in the form of working route, that consists of a sequence of loads and discharges addresses, is issued to transport company. Each loading and downloading is accompanied by a full list of supply orders. The ability to carry out loading and downloading for the vehicle is guaranteed by optimisation algorithm [6] of *planning kernel*.

If, having received the assignment, the representative of the transport company discovers that it cannot be complied for some reason; he should immediately reject the assignment. Non-rejected during a certain time, the assignment is considered as approved for execution. During the route, carrying out loading and downloading, the driver notes in a special routing his actual time, as well as various claims.

The representative of the shop (the recipient of goods)

Daily the representative of the shop receives a list of downloading, which will be made in his address that day. For each downloading, the list of orders is indicated as well as planned time interval of delivery. In general, several vehicles may make all discharges at different times (although the algorithm try to minimize such cases). It is the responsibility of the representative of the shop to fix the facts of downloading, as well as any claims against supplier and carrier.

The representative of logistics center

Daily, the representative of logistics center places orders for delivery in the database portal (or this will happen automatically, based on XML Web-services). The order for delivery includes the following characteristics:

- *Location (logistics center's address);*
- *Where (delivery address);*
- *The interval of time, which should take the goods;*
- *The interval of time, which should deliver the goods;*
- *Type of goods (food / industrial);*
- *Packaging type;*
- *The width, length and height of the cargo unit in terms of the type of packaging;*
- *Number of units of cargo;*
- *Number of invoice;*
- *Who prepares the order;*
- *When issued.*

The type of packaging is one of the preliminary arranged types, which determine the linear dimensions of cargo units. The width, length and height are specified in the order - a monolithic size of one unit of cargo (it cannot be decomposed down into component parts and regrouped in another form).

The representative of logistics center can view the routes of vehicles involved in the execution of his orders. Additionally, he can view the state of execution of his orders in real time on the site (the recipients of goods are obliged to promptly provide such information).

3.4. Organizational aspects of the Internet portal "Riga City Logistics"

The portal can provide services of planning a unified network of supply chains on a commercial basis for licensed users under the auspices of city government. For the functioning of the portal minimal administrative staff and technical support service will be required. In the first phase of the portal, the city government will oblige all companies involved in transport within the city, including logistics centers, to register with the on-line mode. With those companies who wish to participate in the work a special license agreement will be concluded, and they become a power (licensed) user of the system.

To attract the users in the first stage it might need some incentives, such as preferential taxation within the purview of municipal authorities or other measures. Additionally, taking into account all the legal aspects mechanism of financial and legal relationships between all participants in transport operations, including the electronic stock exchanges (portal) personnel, in full accordance with existing legislation should be elaborated.

In case of success in the planning and visible results of implementation it may join the newly independent carriers and transport units to the system in future as well as their own divisions of main companies-owners of the logistics centres.

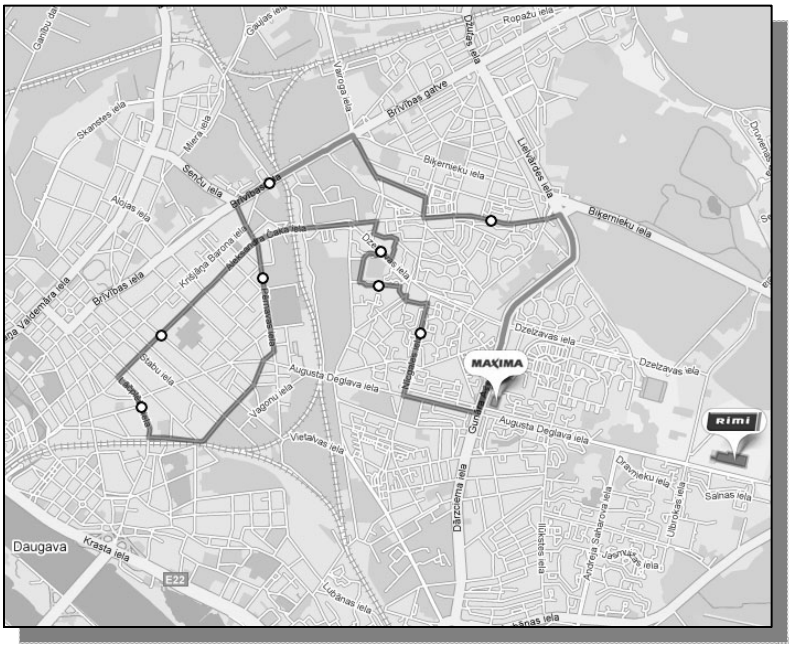

Figure 7. An example of planned optimal route for one vehicle in a single delivery network interface prototype of Internet portal "Riga City Logistics"

Discussion

Functioning portal “City Logistics” is interesting for all involved in the supply of goods participants on the principles of Private Public Partnership (PPP):

- Transportation companies and SME will receive the largest gains from the introduction of such a system, as they will be provided guaranteed volumes of work on the delivery of goods with maximum efficiency use of vehicles without losses (a car full load and the optimal time or distance route). Furthermore, the companies will be able to manage their own maintenance and repair of the vehicle fleet as well as the work of drivers and service personnel more effectively, which should positively impact on road safety.
- Major companies, the owners of logistic centers, will exclude the need of a continual search of the perpetrators of small irregular orders (outsourcing), and more, they will be able to increase the number of orders for small irregular international traffic if supported by WWW portal service in the final phase of delivery.
- It will be possible to talk about joint network supply as a part of the city logistics system, which, using the optimal planning, gives an opportunity to minimize the number of vehicles that carry out the delivery of goods available in the central part of the city. Moreover, there is an opportunity to exclude implementation of routes during peak hours in the busiest urban streets and in the historical center of the city. This, in turn, will affect the intensity of the urban traffic and environmental situation in the city, which is desirable for the State, municipal services and all residents.

Acknowledgements. *The presented research was accomplished with the support and partial funding under the European project „START – Short-term tasks for cargo transport traffic reorganization”, European Commission Intelligent Energy Executive Agency project (2006-2008), grant contract EIE/05/169/SI2.419609.*

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CUMULATIVE INDEX

TRANSPORT and TELECOMMUNICATION, Volume 9, No 3, 2008 (Abstracts)

Vasiliauskas, A. V., Jakubauskas, G., Barysienė J. Analysis of Sustainable Freight and Passenger Road Transport Development Using *ITS*. *Transport and Telecommunication*, Vol. 9, No 3, 2008, pp. 4–8.

The paper presents an analysis of measures to be taken for development of sustainable transport system. Increasing traffic intensity unavoidably requires faster development and modernisation of transport infrastructure, which means not only larger investment but also better transport policy and introduction of more advanced solutions, such as promotion and deployment of ITS – intelligent transport systems and services.

In Lithuania for development of a modern transport system meeting the EU standards and criteria, the key priority is given to development, rehabilitation and modernisation of those transport infrastructure objects that form an integral part of TEN-T. Another as much as significant task is to improve road, railway, water and multimodal transport infrastructure of national and regional significance in order to cope with the growing mobility needs of the society, promote development of business and tourism, and increase competitiveness of the economy. In recent years the ITS deployment policy have been strongly promoted in the national level. Road safety is a further area where substantial improvement is needed, despite significant achievements in the past. Application of ITS is seen as one of the most effective tools in order to improve traffic safety and other areas of transport.

Keywords: sustainable, multimodal, intermodal transport, P&R, ITS

Jakubauskas, G. Improvement of Urban Transport Accessibility for the Passengers with Reduced Mobility by Applying Intelligent Transport Systems and Services. *Transport and Telecommunication*, Vol. 9, No 3, 2008, pp. 9–15.

Deployment of Intelligent Transport Systems and Services (ITS) has been strongly considered as crucial element of improved accessibility for passengers with reduced mobility. Intelligent transport systems in the light of improving an access to urban transport for passengers with reduced mobility are analysed in the article. The need of deployment of these systems in three areas – information, infrastructure and vehicles is emphasized and practical examples are provided. Only in the case if intelligent transport systems are deployed in all the three areas, a seamless transportation for the disabled people is ensured. The aim of the research is to evaluate solutions, encouraged by the EU transport policy and proved by a good practise that might be implemented in Lithuanian urban transport system. These solutions are also based on results of questionnaire, accomplished by the author.

Keywords: mobility handicaps, reduced mobility, sustainability, Intelligent Transport Systems

Cisowski, T., Niewczas, A., Stokłosa, J. Modelling Disturbances in System Track – Rail Vehicle. *Transport and Telecommunication*, Vol. 9, No 3, 2008, pp. 16–22.

All real systems work in disturbances conditions. “Disturbances” term belongs to special category of entry values which are not known before and do not make subject to control, it means they are uncontrolled entry signals. Disturbances are an important element of systems regulation, because usually lead to unexpected effects in functioning of steered systems.

An alternative approach has been proposed in this article in disturbing signals description, related on theory of wave disturbances, which allow describing wide disturbances scale, occurred in suspensions of active vehicles.

Disturbances models based on new wave interpretation can describe wide class of real, indefinite disturbances which occur in suspensions of active vehicles.

Keywords: suspensions, active vehicles suspensions, wavy interpretation of disturbances, Laplace transform random disturbances

Fila, N., Misnevs, B. Methodology Development and Its Implementation in Analytical System for Transport and Logistics Educational Programs. *Transport and Telecommunication*, Vol. 9, No 3, 2008, pp. 23–29.

The purpose of the paper is to present the methodology and its implementation results in the field of statistical research of TTI study process trends by use of analytical system.

The actual analytical system (AS TTI) for data maintenance and analysis was created at Transport and Telecommunication Institute (TTI) based on the OLAP principle [1]. The paper represents experimental results of the analytical system implementation for statistical research of study subjects' interconnections for transport and logistics educational programs.

Advanced technology allows users to perform a multidimensional data analysis for decision making purposes. The system uses independent Data Marts, which are constructed basing on information delivered from actual TTI Information System (OLTP).

The paper emphasizes one of the analytical tasks of study processes management at the university, which has been solved using the AS TTI Data Marts "Analysis of examinations marks for study subjects at different study programs".

As the example of the suggested methodology some correlation coefficients were calculated and analyzed to characterize examination marks interdependency between study subjects for several educational programs in the transport and logistics area. As the result factually existing study subject interconnection was recognized on the base of correlation analyses. The analytical methodology implemented in the AS TTI was recommended as an eventual tool for investigation of study subjects' interconnection, aimed to improve the quality of educational programs.

Keywords: the University Analytical System, OLAP-technology and Data Marts

Grakovski, A., Kabashkin, I., Ressin, A. Intelligent Transport System for Intra-City Logistics Based on WWW Technologies. *Transport and Telecommunication*, Vol. 9, No 3, 2008, pp. 30–38.

Currently in the city of Riga there are several parallel, independent of each other, networks for delivery goods. It is noteworthy that, unlike the major networks, companies doing outsourcing cannot provide the routes full load vehicles and the best routes. In the central part of the city near the same streets perform different trucks delivering goods to customers of neighbouring addresses. The movement, parking and downloading of vehicles produced during the working day and during peak hours, sometimes without taking a single lane road. This creates additional problems for urban traffic, pedestrians and the urban environment. The situation could be improved by creation of a virtual segment of intelligent transport system, planning the work of small transport companies (SME) that would work on outsourcing of logistics centres. The concept of such a system is in creation of the Internet-portal for linking customers and freight transport companies.

Keywords: intelligent transport systems, supply chains, optimisation, vehicle routing problem

TRANSPORT and TELECOMMUNICATION, 9.sējums, Nr.3, 2008 (Anotācijas)

Vasiliauskas, A. V., Jakubauskas, G., Barisiene, J. Ilgtspējīgas kravas un pasažieru autoceļu attīstības analīze, lietojot ITS**.** *TRANSPORT and TELECOMMUNICATION,* 9.sēj., Nr.3, 2008, 4.–8. lpp.

Rakstā tiek piedāvāti pasākumi, kas tiek pielietoti, lai attīstītu ilgtspējīgu transporta sistēmu, un to analīze. Satiksmes intensitātes palielināšanās neizbēgami prasa transporta infrastruktūras ātrāku attīstību un modernizāciju, kas nozīmē ne tikai lielākas investīcijas, bet arī labāku transporta politiku un progresīvāku risinājumu ieviešanu, piemēram, *ITS* – inteliģentās transporta sistēmas un pakalpojumu attīstības veicināšana un izvietošana.

Lietuvā moderno transporta sistēmu attīstībā, kas iet kopsolī ar Eiropas standartiem un kritērijiem, galvenā priekšrocība ir noteikta tādu transporta infrastruktūru objektu attīstībai, rehabilitācijai un modernizācijai, kas veido *TEN-T* integrālo daļu. Lietuvā pēdējos gados *ITS* ieviešanai ir vērsta īpaša uzmanība nacionālajā līmenī. Ceļu drošība ir arī viena no tām jomām, kur ir jāveicina uzlabošanās, neskatoties uz nozīmīgiem pagātnes sasniegumiem. *ITS* pielietojums tiek uzskatīts kā viens no visefektīvākajiem līdzekļiem satiksmes drošības uzlabošanā un citās transporta jomās.

Atslēgvārdi: ilgtspējīgs, multimodāls, intermodāls transports, *P&R, ITS*

Jakubauskas, G. Pilsētas transporta pieejamības uzlabošana pasažieriem ar kustību ierobežojumiem, pielietojot inteliģentās transporta sistēmas un pakalpojumus. *TRANSPORT and TELECOMMUNICATION,* 9.sēj., Nr.3, 2008, 9.–15. lpp.

Inteliģento transporta sistēmu un pakalpojumu (*ITS*) izvietošana tiek stingri uzskatīta par kritisku elementu transporta pieejamības uzlabošanā pasažieriem ar kustību ierobežojumiem. Inteliģentās transporta sistēmas, kas paredzētas pasažieriem ar kustību ierobežojumiem, tiek analizētas dotajā rakstā. Šo sistēmu izvietošana ir nepieciešama trijās jomās – informācijā, infrastruktūrā un satiksmes līdzekļos un līdz ar to rakstā tiek doti praktiski piemēri.

Pētījuma mērķis ir novērtēt šos risinājumus, kurus piedāvā Eiropas Savienības transporta politika un kura ir aprobēta ar labu praksi, kas arī varētu tikt ieviesta Lietuvas transporta sistēmā.

Atslēgvārdi: kustības handikaps, ierobežota kustība, ilgtspēja, inteliģentās transporta sistēmas

Cisovskis, T., Ņevčas, A., Stoklosa, J. Modelēšanas traucējumi kravas dzelzceļa transporta sistēmā. *TRANSPORT and TELECOMMUNICATION,* 9.sēj., Nr.3, 2008, 16.–22. lpp.

Visas reālās sistēmas strādā traucējumu apstākļos. Termins "Disturbances" pieder īpašai sākuma vērtību kategorijai, kura ir nezināma sākotnēji un neveido kontroles priekšmetu, tas nozīmē, ka tie ir nekontrolētie sākuma signāli. Traucējumi ir svarīgs sistēmas regulēšanas elements tāpēc, ka parasti ved pie neparedzētiem efektiem vadāmo sistēmu funkcionēšanā.

Šajā rakstā autori piedāvā alternatīvu pieeju traucējamo signālu aprakstā, saskaņā ar viļņu disturbanču teoriju, kura atļauj aprakstīt plašu disturbanču mērogu, kas rodas darbojošamies satiksmes līdzekļu sastrēgumos.

Disturbanču modeļi, kas par pamatu izmanto jauno viļņu interpretāciju, var aprakstīt plašu reālo, nenoteikto disturbanču grupu, kas parādās darbojošamies satiksmes līdzekļu sastrēgumos.

Atslēgvārdi: sastrēgumi, darbojošamies satiksmes līdzekļu sastrēgumi, disturbanču interpretācija ar viļņu palīdzību, Laplasa transformācija nejaušās disturbancēs

Fiļa, N., Mišņevs, B. Metodoloģijas attīstība un tās ieviešana Izglītības programmu analītiskajā sistēmā, kas paredzēts transportam un loģistikai. *TRANSPORT and TELECOMMUNICATION,* 9.sēj., Nr.3, 2008, 23.–29. lpp.

Raksta mērķis ir parādīt metodoloģiju un tās ieviešanas rezultātus TSI studiju procesa statistiskā pētījuma laukā, lietojot analītisko sistēmu.

Analītiskā sistēma (AS TSI) datu saglabāšanai un analīzei ir radīta Transporta un sakaru institūtā (TSI), pamatojoties uz *OLAP* principu [1]. Rakstā tiek parādīti eksperimentālie rezultāti analītiskās sistēmas ieviešanai statistiskajam pētījumam par studiju priekšmetu savstarpējo saistību transporta un loģistikas izglītības programmās.

Uzlabotā tehnoloģija atļauj lietotājam veikt multidimensionālo datu analīzi lēmumu pieņemšanā. Sistēma pielieto neatkarīgos *Data Marts*, kas ir uzbūvēti, pamatojoties uz informāciju, kas piegādāta no faktiskās TSI Informācijas sistēmas (*OLTP*).

Rakstā tiek uzsvērts viens no studiju procesa vadības universitātē analītiskajiem uzdevumiem, kas tika atrisināts, lietojot AS TSI *Data Marts* „Studiju priekšmetu dažādās studiju programmās eksaminācijas atzīmju analīze”.

Kā piedāvātās metodoloģijas piemērs tika izskaitļoti daži korelācijas koeficienti un arī izanalizēti, lai raksturotu eksaminācijas atzīmju savstarpējo atkarību starp studiju priekšmetiem dažām izglītības programmām transporta un loģistikas jomā. Pamatojoties uz korelācijas analīzēm, rezultātā tika konstatēta faktiskā pastāvošā studiju priekšmetu savstarpējā sakarība. Analītiskā metodoloģija, kas ir ieviesta AS TSI, tika ieteikta kā eventuāls līdzeklis studiju priekšmetu savstarpējās sakarības pētīšanai, kas, savukārt, uzlabotu izglītības programmu kvalitāti.

Atslēgvārdi: universitātes analītiskā sistēma, *OLAP* tehnoloģija un *Data Marts*

Grakovskis, A., Kabaškins, I., Ressins, A. Inteliģentā transporta sistēma, kas paredzēta pilsētas loģistikai un pamatota uz WWW tehnoloģijām. *TRANSPORT and TELECOMMUNICATION,* 9.sēj., Nr.3, 2008, 30.–38. lpp.

Pašlaik Rīgas pilsētā ir vairāki paralēli, neatkarīgi viens no otra tīkli, kas piegādā preces. Tas ir svarīgi, ka neskatoties uz to, ka lielākie tīkli, kompānijas, veicot līgumdarbus, nespēj nodrošināt maršrutos pilnu kravu transportam un noteikt labāko maršrutu. Pilsētas centrālajā daļā vienu un to pašu ielu tuvumā dažādi kravas transporta auto veic vienu un to pašu preču piegādi kaimiņos esošās adresēs. Kustība, parkošanās un izkraušanās darbi, ko veic transporta līdzekļi darba dienas laikā un maksimumstundu laikā, dažreiz pat neiebraucot šķērsieliņā – tas viss minētais rada problēmas pilsētas satiksmei, gājējiem un pilsētvidei. Situāciju varētu uzlabot, radot inteliģentās transporta sistēmas virtuālo segmentu, plānojot mazo transporta kompāniju darbu, kas strādātu līgumdarbus loģistikas centros. Šādas sistēmas koncepts ir radīšanas stadijā interneta portālā, lai apvienotu klientus un kravas transporta kompānijas.

Atslēgvārdi: inteliģentās transporta sistēmas, piegādes ķēdes, optimizācija, transporta maršrutu problēma

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