Session 1

Transport Systems

RESEARCH OF TRANSPORT SYSTEM INFLUENCE ON ECOLOGY OF THE CITY

Stanislav Grishin, Eugene Kopytov, Oleg Shchiptsov

Transport and Telecommunication Institute
Lomonosova, 1, Riga, LV-1019, Latvia
Phone: (+371)7100650. E-mail: kopitov@tsi.lv

An interesting aspect of ecological research is a question, connected with transport system influence on ecology of the city. City transport is one of the biggest pollutants of city environment. On average more than 80% of atmosphere pollution in Europe cities comes from motor transport. In this article we can see a scheme of interaction of tasks on calculation losses from the polluted environment by transport system, different ways and methods of researches on city transport problem for ecology. Finally the results of the given researches will help us at solving city problems of transport ecology of Riga city by the method of consequent approaching norms in European Union.

Keywords: transport, destructive influence, ecological situation, ecological monitoring

1. INTRODUCTION

An interesting aspect of ecological research is a question, connected with transport system influence on ecology of the city. City transport is one of the biggest pollutants of city environment. On average more than 80% of atmosphere pollution in Europe cities comes from motor transport [1]. In cities, which do not process anything this index of transport influence can be even higher. Besides, the level of pollution considerably depends on type of vehicle. Motorcars, trucks, buses and cabs have a bigger influence on ecology than trolleybuses and trams. Whether all-electric suburb railway transport does not pollute the environment, it is a serious source of vibration and noise.

Generally city transport operation leads to:

- Increasing of exploitation of natural resources;
- Pollution of the air basin, water objects and soil;
- Creation of high level of noise, vibration and electromagnetic radiation;
- Traumatism and loss of people and animals in car accidents;
- Debasement of human health (cancer, cardiovascular and other diseases);
- Debasement of plants germination conditions, their degradation and destruction;
- Destroying and deserting lands for transport objects, destructing influence of transport operation waste.

According to increasing amount of vehicles in Riga, intensity of traffic considerably grows and leads to traffic jams (not only in peak hours anymore) and continuous miss in public transport communication schedules. The difficult situation needs researches directed to solving the ecologic problems of the city [1] and decreasing the trend of increasing transport influence on ecology of the city to comply with ecological rates in European Union not only today, but also in the future [2, 3].

To approximate solution of transport ecological problem of the city it is necessary to analyse types of vehicle influence and define a polluted environment damage valuation interconnection scheme.

2. VEHICLE INFLUENCE ON ECOLOGY OF THE CITY

Basic types of vehicle influence on natural and imitation ecosystems are displayed on Figure 1.

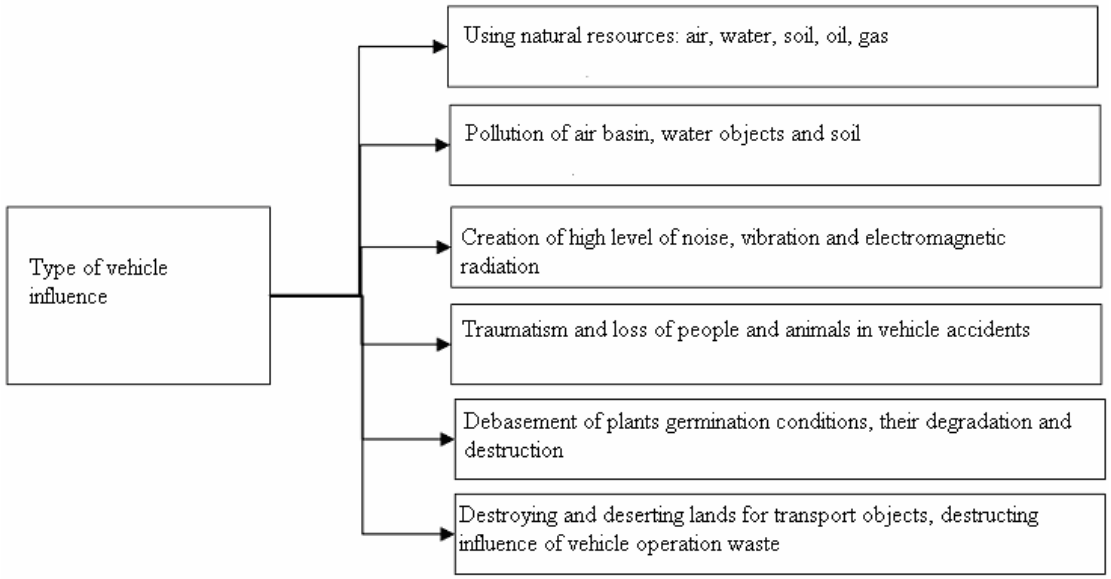

Fig. 1. *Basic types of vehicle influence on natural and imitation ecosystems*

As a result of that influence the following contraventions appears in ecology of the city:

- pollution of the environment by vehicles;
- pollution of the environment by stationary sources on transport;
- vibration and noise influence of vehicle;
- consequences of vehicle accidents;
- negatory influence of vehicle on vegetation of the city;
- negatory influence of vehicle on human health.

Now let us look through those contraventions more carefully by analysing causes of each negatory influence.

Pollution of the environment by vehicles

The main pollution is a result of gas burn out. The chemical content of exhaust depends on gas type and quality, processing technology, burn out technique inside of motor, its technical condition and following filtration of exhaust [4, 5]. Let us peruse the basic types of exhaust, which creates by burn out process in vehicles.

- *Innocuous exhaust*: nitrogen, oxygen, hydrogen, water vapour, carbon dioxide, etc. Those are natural components of air in the atmosphere. The main influence in this list has carbon dioxide (CO_2). It is the one which influences the greenhouse effect the most.
- *Carbon monoxide* (CO). It has a strong poisonous impact on live organism and leads to death at concentration of 1%.
- *Nitrogen oxides*: (NO and NO_2) heavy colourless gasses. Create acids by interacting with water: nitric acid, nitrous acid, etc. They construct nitrites in organism and take part in photochemical reaction of smog and acid rain formation.
- *Hydrocarbons* (C_xH_y). There are about 160 linkages. They format as a result of incomplete burn out of gas in engine and are one of the causes of white or blue smoke. They are cancerous. By taking part in smog, they take part in photochemical reaction with nitrogen oxides and process toxic products as a result – photo oxidants; highly toxic and chemically active ozone – the main component of smog, which causes lungs diseases, corrosion of rubber, metals and deteriorates visibility.
- *Aldehydes* (CH3, C6H5, etc.) – organic linkages (formaldehyde has an odour of gasses exhaust; akrolein is poisonous itself; vinegar aldehyde is toxic).
- *Sulphurous linkages.* They have irritant effect on organism and fatal for nature.
- *Lead.* It has a cumulative effect. It accumulates in human or animal organism.

Vehicle wear and tear also causes pollution in the city. First of all we should mention *microscopic parts of heavy metals:* zinc, silver, nickel, etc, which formats because of wear and tear of

vehicle mobile parts. If heavy metals salts (nickel, chrome, zinc, etc. used in galvanization) are placed in open dump, they dissolve in a rainfall impression and reach underground water. This scheme is the most dangerous for people and environment.

We should mention that the content of the exhaust of diesel engines differs from gas ones (see Table 1). In diesel engine burn out of gas is more complete, so that there is less carbonic oxide and unburned hydrocarbons, but because of short of air in diesel more nitrogen oxides emerge. The singularity of processed diesel engine gasses is a content of cancer poly-cyclic aromatic hydrocarbons and the most destructive among them is dioxin (cyclic ether) and benzopyren. The last one, just as lead, belongs to the first class of dangerous polluting substance. Dioxins and similar linkages are many times more toxic than such poisons as curare and potassium cyanide. Quantity of toxic components (in g) results from burn out of 1 kg gas characterises data, presented on Table 1 [5].

Table 1. Quantity of toxic substance from 1 kg gas burn out

Gas types / Polluting substance	Gas, g	Diesel Fuel, g
Carbon monoxide	465	21
Hydrocarbon	23	4
Nitrogen oxides	15	18
Sulphur dioxide	2	8
Aldehyde	1	1
Smut	1	5
Lead	0,5	0
Total, g	**507,5**	**57**

Pollution of the environment by stationary sources on transport

Territories and enterprises which operate vehicle and traffic are called stationary sources on transport. The following stationary sources on transport greatly effect the environment: oil depots, fuel storehouses, boiler houses, stations, vehicle parking-places, auto services, and utilisation of vehicles, wheels, accumulators, oils and sleepers. They cause pollution of air in the atmosphere, waste water, rainfalls of waste water, polluted by oil products, soil pollution.

Creation of high level of noise, vibration and electromagnetic radiation

Any unwelcome sound, which disturbs our working or relaxation and makes phonic discomfort we consider as a noise. Let us extract basic factors, which effect vibration and noise influence of traffic:

- vehicle intensity: the greater the intensity is, the higher is noise influence on the environment;
- structure of vehicle: truck or automobile: truck makes much more noise than automobile;
- type and quality of road surfacing: asphalt surfacing makes much less noise, then comes concrete, rock, broken stone surfacing; besides, damaged surfacing of any type causes much more noise;
- planning territory decisions: street profiles, signal lights and other contents of traffic effect engines operation, as follows, they affect produced noise; during planning the territory it is necessary

to consider that wideness of acoustic discomfort zone along arterial road can reach 700-1000 metres that depends on proximal buildings type;

- green areas: they are not only a resistor for noise but also neutralise a great amount of destructing exhaust; especially favourable effect give broad-leaved trees; in this context an important problem is protecting the green areas of cutting out and providing greening system improvement in cities.

Also we should mention index of noise effect:

- *Intensity.* It characterises level of sound pressure, which process waves to eardrum. In Table 2 we can see index of noise effect (dB), assumed in standard sound metre. During vehicle noise characteristic evaluation must be considered that noise above 80 dB is harmful for human organism twinge threshold is between 120-130 dB. Besides, the limit of human body persistence is about 154 dB [1, 5]. From the Table 2 you can see that noise characteristics of busses, trucks, trains and reactive airplanes while taking off (airports are usually situated inside the city) are harmful for human health.

Table 2. Vehicles noise characteristics

Vehicle type	Noise effect, dB
Boat (25 metres from the board)	68-72
Cargo ship (25 metres from the board)	70-74
Motorcar	70-80
Bus	80-85
Lorry	80-90
Railway rolling stock (7 m from cart-wheel)	95-100
Railway rolling stock (at the cart-wheel)	125-130
Reactive airplane while taking off	130-160

- *Sound pitches* (Hz). By this index sounds can be divided as follows:
  - Infra-sound (less than 20 Hz causes sense of fear) (I).
  - Acoustic (audible) – from 16-20 to 20 000 Hz (II).
  - Ultrasound (high-level) – from 20 000 to 10^9 harmful for human beings (III).
  - Hyper sound – from 10^9 to 10^{13} Hz (IV).

According to this we have a range of audition perception that depends on frequency and power of the sound. We can see those ranges on Fig. 2. The range A characterizes zone of vehicle influence on people. Curvilinear 1 shows twinge threshold, which is characterized by the less power of sound that causes discomfort, which turns into feeling of pain; curvilinear 2 – threshold of audibility, which complies with the less power of sound, audible at the given frequency.

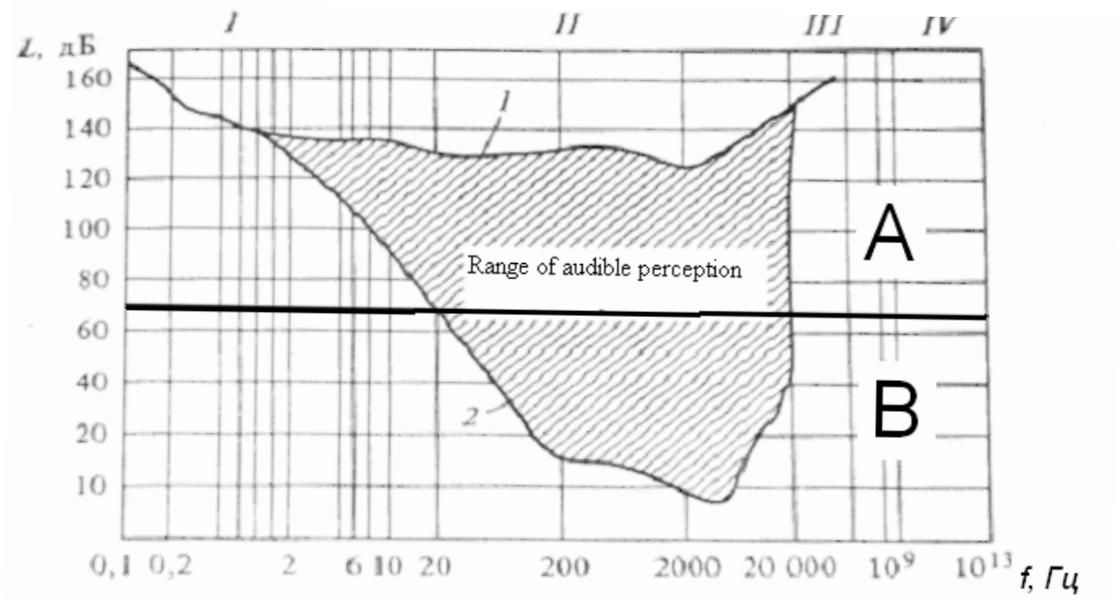

Fig. 2. *Range of audible perception that depends on frequency (f) and power of sound (L)*

- *Duration.* Longer duration of noise influence harmfully effects audition and general health condition of human being.
- *Vibration* (railway, tram, lorry, trolleybus is one of the main sources of vibration). Mechanical vibration propagates through the ground, affecting basics of the buildings, constructions by causing vibration and low-frequency noises. Affects strut and move apparatus of human, cardiovascular and nerve systems, and also capacity.
- *Electromagnetic radiation.* By the type of affecting biological objects radiation can be divided in ionised and unionised radiation. It is a distant ultraviolet, x-radiation, gamma rays. Influence of electromagnetic field in doses, reaching beyond permissible norms, that badly affects vitality of live organisms. Electromagnetic radiation is a very important factor and needs special research.

Consequences of vehicle accidents

On Table 3 the data that characterizes people loss in transport accidents in Russia [1] are shown. There is similar trend in Latvia and other Baltic States.

Table 3. Number of people death in vehicle accidents

Vehicle type	2000	2001	2002	2003
By railway transport	3	5	4	3
By automobile	29 600	30 900	33 200	35 600
By internal water transport	7	0	6	3
By air transport	20	218	131	29

From the Table 3 we can see that the most dangerous is automobile transport. Besides, the main causer is a human factor. It influences the situation the most and causes 80-90% of accidents. Currently increasing the quality of ecological background and qualifying specialists at dangerous truck loads transporting is an urgent problem.

The authors stress upon that in railway transport the accidents with transporting dangerous loads are the most harmful ones.

Vehicles influence on green area of the city

Because of vehicle exhausts the environment for animals and birds living is much polluted, there is loss of fertile soil (soil removal for building and exploitation of the roads lead to soil erosion), population of birds and animals has run short because of noise, vibration and exhausting, pollution in their living areas, many animal vehicle accidents, human health is damaged (cancer diseases), etc.

There are city objects on Fig. 3, which are subordinated to destructive influence of vehicles.

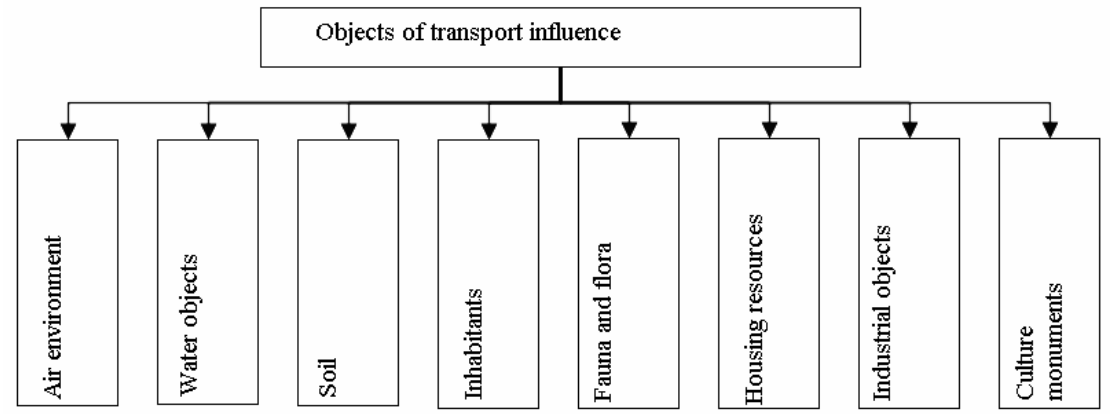

Fig. 3. *Objects of the destructing influence of vehicles*

Very interesting are data about different types of vehicles as parts of influence on causing polluting substances in atmosphere of the city [1, 5]. Table 4 demonstratively illustrates the percentage of that influence.

Table 4. Parts of polluting substances in depending on type of vehicles

Vehicle types	Part of polluting substances, %
Automobile transport	95.6
Air transport	1.2
Railway transport	1.1
Sea transport	0.6
River transport	0.6
Road cars	0.9
Total	***100.0***

From the Table 4 we can see that the main fault in environmental pollution is because of automobile transport and constructs more than 95%. Thus, the main task for solving ecological problems on urbanized territory is solving ecological problems with automobile transport.

3. SCHEME OF REGULARITY OF DESTRUCTING CONSUME BECAUSE OF TRANSPORT SYSTEM ENVIRONMENTAL POLLUTION

From the point of view of formal access to solving problem we can talk about maximization (minimization) of functions:

E=f(X,Y),

where X – navigable variable vector; Y – unavoidable variable vector. These vectors can be in real situations, connected with solving practical tasks. Navigable variable are those contents of transport influence, which we can generally change within real possibilities of administrative structures of the city, provided by complex of organisation enterprises. Unavoidable variable are those contents, which we can not affect in general. It is possible to try to decrease number of unavoidable variable, which needs special projects elaborating and serious investment.

Example. The idea of ecological consume of *i* system is calculation of exponent $E(i)$ with formula:

$$E(i) = E_{measure}(i) + E_{damage}(i),$$

where $E_{мер}(i)$ are expenses for environment protection enterprises in *i* system; $E_{ущерб}(i)$ – losses because of harmful influence on the environment.

In practice calculation of losses amount for all types of pollution and calculation expenses for environment protection enterprises can be held with special methods.

The given tasks are quite complicated because of great amount of interacting factors. They predict general collecting of statistic data, got as a result of numbers of different objects observations like concentration of polluting substances in different environmental conditions, metered in exact points in exact time. On the other side, in such systems there must be data about all environment protection enterprises or about increasing ecological conditions, indexes of such enterprises effectiveness, etc. Besides, storing and processing of the collected information is possible only on special base. Basis of such systems are huge data bases (DB), where the Principe of decomposition is usually used in projects. One of prospective trends of realisation the given project Principe can be used – data storing technology. The following scheme of system ecological consumes tasks and data sources basic groups interacting are offered in Fig. 4.

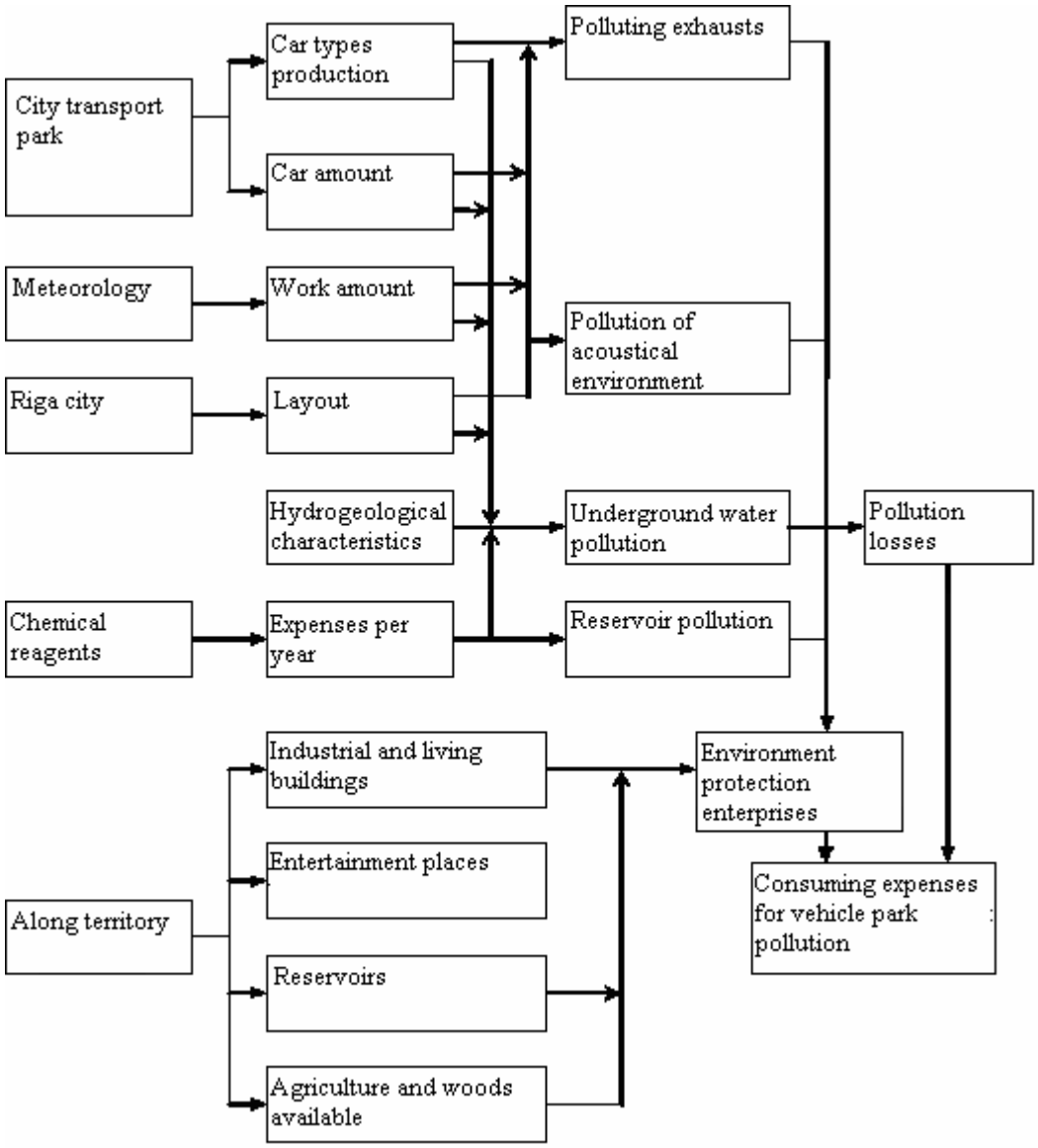

Fig. 4. *Scheme of system ecological consumes tasks and data sources basic groups interacting*

The given scheme of interacting can be used in researches on transport ecological problems of the city.

In general researches the authors have applied the including of a combination of theoretic and technologic ways of organization in calculating the task. For example, organization technology way means compatible of city structures, which account for transport and connection; in theoretic way of solving ecological problems including coordination of strength for transport processing, taking to account ecological risks [4, 5]. Theoretic ways prescribe wide using of theory of possibility, mathematic statistics, imitation modelling and operation researches [6, 7].

Researches must be combined and are to include a great number of fields. For example, for Riga city rather topical are the following tasks:

1. City transport web characteristics analyse from the ecological point of view all types of vehicle (motorcars and lorries, busses, trolleybuses, trams, cabs, route cabs, urban railway transport).
2. Comparing analysis of ecological situation in the city at the moment and in the future.
3. Producing ecological monitoring system in the city.
4. Collecting and processing information about transport ecology.
5. Determination of transport ecological risks calculation methods.

6. Working out a conception of decreasing transport ecological risks in the city.
7. Working out a city transport development conception, considering transport ecological risks.

Each of the named research points is urgent for the city, but we still can mark out a problem, which is necessary to be solved first and it is setting up a constant monitoring system for non-stop observation of city environment condition because of vehicle exhausts and processing all collected information.

CONCLUSIONS

In this article we can see a scheme of interaction of tasks on calculation losses from polluted environment by the transport system, mentioned ways and methods of researches on city transport problem concerning the ecology. Finally the results of the given researches will help us to solve city problems of transport ecology of Riga city by the method of consequent approaching norms in European Union.

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EXPORT OF WASTEPAPER FROM ESTONIA TO CHINA – ASSUMPTIONS FOR CHINESE CONTAINER FLOWS THROUGH ESTONIA

Andres Tolli[1], Hanh Dam Le-Griffin[2]

[1]Institute of Roads, Tallinn University of Technology
19086 Tallinn, Estonia
Phone: +372 6770391. Fax: +372 6202601. E-mail: andrestolli@hot.ee

[2]Department of Civil and Environmental Engineering
University of Southern California, Los Angeles, CA 90089, USA
Phone: +1 2132812905. Fax: +1 2137408662. E-mail: hdle@usc.edu

In this paper, wastepaper is evaluated as a global commodity in relation to different trade flows originating in, and destined for, China. Across all commodities and combined between exports and imports, Chinese container traffic comprises over 30% of world container traffic. From 2005 to 2006, container traffic at the ten largest Chinese ports grew by approximately 25%. As such, in terms of total world share and rate of growth, Chinese container traffic represents important cargo flows for Europe and USA, including also the Baltic countries and Russia. However, these aggregate trade statistics conceal a persistent problem associated with trade flows into China: the return of empty containers.

The scale of this concealed problem is surprisingly large, with a large share of the inbound containers being empties. This problematic trade pattern in global trade is now replicating itself in trade between Russia and China. It is generally known that, starting from 2004, Russia and China have been planning to increase their bilateral trade from 29 billion US dollars to 80 billion US dollars by the year 2010, a six-year period. Russia exports mainly mineral and energy resources to China, and China exports manufactured goods in marine containers to Russia. Mineral resources are usually transported to China via railway, pipe transport, or bulkier vessels or tankers. Therefore the majority of containers returned to China are empty and the transport costs of empty return containers are not adequately covered by revenues.

Annually, 21% of Russia's exported oil products pass through the Port of Tallinn. As the largest Estonian port, the Port of Tallinn has many years of experience servicing Russian cargo and has accordingly developed the institutional skills and demonstrated the quality of service necessary to potentially handle a substantial share of Russian import and export container flows. The flow of cargo exported from China to Russia in containers has been growing more than 40% a year, and Russian retail trade has been increasing more than 50% per year. At the same time, new container terminals planned for the Russian ports have not yet been completed (for example Ust-Luga). Therefore, the Port of Tallinn is in a good position to capture a fair part of the cargo flows between Russia and China.

This paper provides a global analyse on freight flows by commodity to and fro China with focus on a comparative analysis on possible export cargo to China. Our goal is to explore the possibility and logistics mechanism to promote the growth of container volume from China to Russia via Estonia. In developing our analysis, wastepaper is considered in this paper as one of the potential export commodities from Estonia to China. The potential of this commodity to fill containers that would otherwise be repositioned empty to China, and the possibility of consolidating empty containers at the Port of Tallinn from other trade flows with China, is examined.

Keywords: wastepaper, container, market, import, export

1. INTRODUCTION

In Estonia, Latvia and Lithuania a total of 7.56 million people live on 175 000 sq km [1]. Comparing the three Baltic countries with Finland, here the number of population is larger by almost 48% on a territory half as small. In Russia 142.89 million people live on a 17,075,200 sq km large territory. Chinese potential is also confirmed by 1.313.973.713 people living on a 9,596,960 sq km size territory [1].

As mentioned beforehand Russia's import in containers keeps growing rapidly and analogous trends also exist in Baltic countries. These four countries have a similar problem in trade with China, where the cargo flow imported from China clearly exceeds the flow of exported cargo. At the same time all four countries have a common characteristic – trade with China increases rapidly. In addition to rapid growth of trade also the growth of GDP of China, Estonia, Latvia and Lithuania is rapid.

The biggest difference between the four countries lies in the fact that Russia exports mostly its own energy carriers, like oil and coal, to China. Estonia, Latvia and Lithuania lack their own energy carriers in the form of mineral resources. At the same time the three Baltic countries participate in the transport of Russian energy carriers and mineral resources as transit countries and import cargo from China in containers. The biggest potential of Estonian ports is to become one of the gates through which containers sent from China to Russia continue their trip to Russia. As container flow to Russia is large it is highly important to find from Russia and the three Baltic countries enough commodities returned to China in containers. This enables to keep the number of empty containers returned to China as low as possible, which surely serves as one important argument in cargo flow logistics.

Next based on world practice we analyze different cargo groups transported to China and provide a comparative analysis of cargo exported to China. We are looking for possibilities how to increase the number of containers sent from China to Russia via Estonia. We also offer a possibility to decrease the flow of empty containers returned from Russia to China.

2. WASTEPAPER AS AN EXPORT ARTICLE

Paper plays an important role in our everyday life. On the other hand, using paper creates a lot of wastepaper, which for the most part goes to garbage. By detaching wastepaper from garbage generated in offices magnificent results can be achieved lowering garbage invoices up to 50%. By producing paper from wastepaper up to 55% less of energy than upon producing paper from wood is used in the production process and the environment is polluted less by up to 95%. Also, 77% of paper thrown away in offices can be reused [2].

Wastepaper transported in marine containers is also a commodity article in trade between countries. The market of reusable wastepaper is very active in the world and it grows by year. The largest quantity of reusable wastepaper is reprocessed in Asia. US wastepaper export has become an important part of the world's largest trade between the USA and China (211.63 billion US dollars in 2005). China is the major supplier of the USA with furniture, toys, clothes, electronics, footwear and other commodities [3]. The majority of commodities are transported in marine containers between the two countries. It is of high importance that the marine containers filled with commodities sent from China to the United States of America would not be transported back to China empty. According to the statistics of 2005 out of one hundred marine containers sixty were transported back from the USA to China empty [4]. Year by year increasing trade between the two countries needs a balanced cargo flow back to China. Financially the world powers have not succeeded in keeping the trade in balance. As of 2005, the US trade deficit with China amounts to 201.7 billion US dollars.

As one possibility the amount of empty containers returned from the United States of America to China is decreased by transporting wastepaper in marine containers. In the USA active wastepaper collection and processing in millions of tons according to different wastepaper quality is performed. As a result of this activity the United States of America with 14.13 million tons per year has become one of the major wastepaper exporters in the world [6]. The annual amount of wastepaper exported from the USA to China comprises 52.7% of the US wastepaper export [6] [7]. According to the forecast import of wastepaper into China comprises almost half of the world's total wastepaper import this year.

All countries actively trading with China and other Asian countries deal with the solving of the issue of empty marine containers returned to Asia. China experiences analogous problems in trade with Europe and Russia. As the majority of Port of Tallinn cargo flow is made up of transit cargo flows (based on the results of 2006 to the extent of 84.4%) [11], from these mostly of oil products, which cargo volume could substantially decrease in the future due to the development of Russia's own ports, it is important to widen the selection of transit cargo and create possibilities in the port for different countries between which the transit trade in the port would take place. One of the most rapidly growing cargo groups in the Baltic Sea includes container transport, increasing by 16% during 2006 compared to 2005 and comprising a total market volume of 3.7 million TEU [11]. The container flow passing through Russian ports continues to go rapidly and comprises the vast majority of the Baltic Sea market volume. For example in 2006, Port of St. Petersburg serviced 1.45 million containers. Due to the rapid growth of container flow accumulation of containers has occurred in Port of St. Petersburg. Already for years Russia has planned to construct new container terminals on the coast of the Baltic Sea, which would help to increase the throughput capacity of container traffic Russian ports, but until presently there has not occurred any major breakthroughs.

Russia mostly exports to China mineral and energy resources and China exports to Russia commodities in marine containers. Mineral resources are usually transported into China using railway transport, pipe transport or bulker vessels or tankers. Therefore the majority of containers returned to China and Asia are empty and the transport costs of empty container are not covered by revenue.

Due to expanding trade between China and Russia and lack of new container ports in Russia until presently and the need in addition to Moscow and St. Petersburg to supply other large Russian regions with container cargo (like Nizhniy Novgorod, Kazan) Port of Tallinn has a possibility to become a tender of container flows directed from China to Russia. Project realization is supported by the construction of a reusable material plant in the port, as a result of which the number of empty containers returned to China would decrease. This in turn assumes extensive wastepaper collection, sorting and packaging. Changing of legislation, rise in garbage prices and increase in consumer awareness and rise in living standard contribute to the constant increasing of wastepaper market volume in Estonia. Based on the opinion of specialists the annual reusable wastepaper market volume in Estonia is 65 000 tons and according to the forecast the market volume will increase minimally by 10% every year. The total market volume of reusable wastepaper in Estonia, Latvia and Lithuania is 307 000 tons per year [14]. These quantities indicate the actual potential of the market, considering the quantity of reusable wastepaper per one person in a year. Hereby comparing countries most producing reusable wastepaper as a ratio of the quantity of reusable wastepaper and population, we will get the following results (kg of wastepaper per one inhabitant in a year): USA 183 kg, Japan 158 kg and Germany 174 kg. The corresponding data for the Baltic countries is the following: Estonia 49 kg, Latvia 41 kg and Lithuania 42 kg. In Russia the corresponding figure is 4 kg and in the other neighbour of Estonia – Finland 162 kg. In China 13 kg of reusable wastepaper per person in a year was produced.

3. PORTS OF LOS ANGELES AND LONG BEACH – ENGINES OF CHINESE CONTAINER FLOW IN THE WORLD

Next we analyse trade between USA and China taking place on the basis of the best practices and major trade partners of China.

Los Angeles, located in the state of California, accommodates two largest ports of the United States of America - Ports of Los Angeles and Long Beach. Los Angeles is the biggest trade area of the United States of America, leaving behind such large cities as New York and Detroit. Based on GDP in 2005 the economy of the state of California with 1.55 trillion USD ranked among the world ten largest economies, which is in the same magnitude as the economy of entire Russia (1.59 trillion USD) [15]. The Ports of Los Angeles and Long Beach experience a trade of 294 billion USD, whereas the majority of cargo flow or almost 80% is transported in containers.

Based on the results of 2005, when the twin ports serviced a total of 14.19 million TEU (twenty-foot equivalent unit), they ranked fifth in the ranking of the largest world container ports after Port of Shenzhen in China and before Port of Busan in South Korea. In 2006, Ports of Los Angeles and Long Beach serviced already 15.76 million TEU [10].

The trade of the twin ports of Los Angeles and Long Beach is above all based on cargo flow originating from Asia. The largest partners of Los Angeles include the state of China with 102 billion USD, whereas it comprises 36% of the entire trade between China and USA [16].

The twin ports of Los Angeles are important transit ports, as over 40% of cargo continues its transport to the inland of the United States of America [16]. The possibility of Estonian ports includes also the servicing of containers transported from China as transit ports on the route to Russia and Europe.

In contradistinction to other US ports the Ports of Los Angeles and Long Beach have managed to keep the number of empty containers returned to China low. Based on 2006 statistics, the share of empty containers returned to China in Ports of Los Angeles and Long Beach is only 31%. From the United States of America 60% of all containers were returned to Asia empty [4]. In Estonia together with Latvian and Lithuanian markets it is possible to develop in addition to scrap metal also a sector dealing with extensive plastic collection and processing and exporting to China.

In addition to the infrastructure of the twin ports also hinterland infrastructure is well-developed, consisting of roads and Alameda corridor passing through Los Angeles for rail transport. The almost 32 kilometre long and 2 billion USD costing corridor connects the Ports of Los Angeles and Long Beach with the main transcontinental rail networks. Hence, still the majority of containers or 72% moves in and out of the port using auto transport and the share of rail transport remain 28% [17]. For comparison in

Port of St. Petersburg, the largest Russian container port (almost 1.5 million TEU per year), the share of container transport is 5% and in Port of Tallinn, the largest port of Estonia, it is 7% [11].

Let's analyse the export cargo volumes of both twin ports.

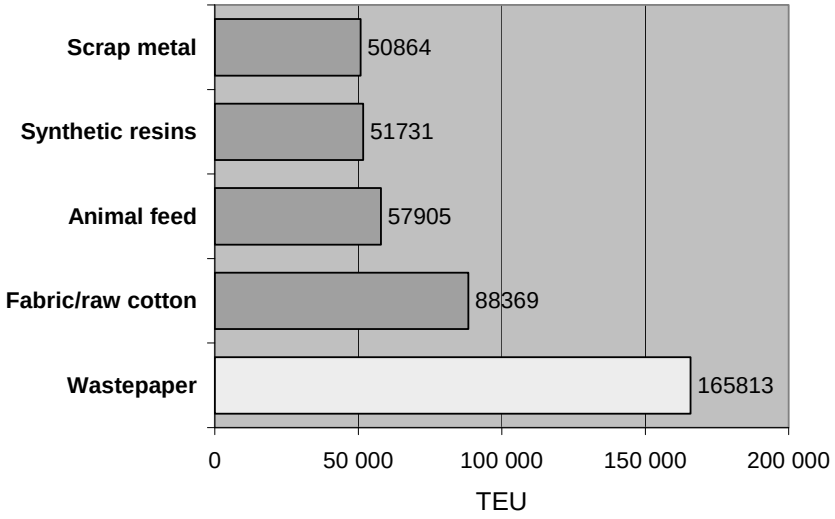

***Figure 1**. Port of Los Angeles top 5 in 2005 containerized export in TEU [17]*

Based on statistics in volume wise the largest export article in containers in Port of Los Angeles TOP 5 containerised cargo transport includes wastepaper 166 000 TEU or 41%, then follow cotton (88 369 TEU) or 21% and animal feed (57 905 TEU) or 14%. Scrap metal as an important reusable material ranks fifth in the ranking of figure 1 [17].

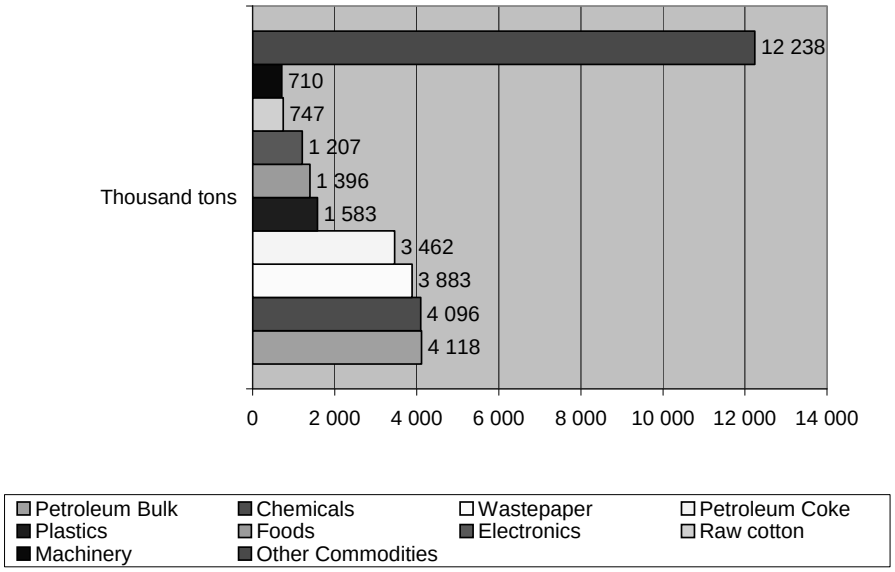

***Figure 2**. Port of Long Beach top 10 in 2005 outbound commodities [18]*

The most popular export articles of Port of Long Beach in monetary value include machinery and mechanisms, plastic and electrical equipment. As the figure indicates export of reusable materials captures an important place in both rankings, where in addition to wastepaper considerable quantities of plastic and scrap metal are exported [18]. The reprocessing plants of wastepaper and plastic are located in the direct proximity of the ports, where also loading of reusable materials into containers and from there on transport to the export using car transport is performed. The small share of empty containers returned to Asia is surely an argument worth mentioning for the continuing increase of import-container flow into the twin ports of Los Angeles.

For comparison in Port of Tallinn the volume of container transport is only 3% and from reusable materials the share of scrap metal is 8%. Differently from the ports of Los Angeles and Long Beach, majority of scrap metal (excl. non-ferrous scrap metal) is transported from Port of Tallinn as bulk cargo on bulker vessels, not containers like in US larger ports.

4. WASTEPAPER VOLUMES OF ESTONIA, LATVIA, LITHUANIA AND RUSSIA

A total of 7.56 million people live in Estonia, Latvia and Lithuania. In Russia the population is 142 million. As collection of wastepaper in Russian regions differs largely, we will analyse the fast growing Russian cities of Moscow and St. Petersburg and the province of Moscow and the province of Leningrad, where collection of wastepaper is more developed. Also, consumption in the given regions is larger compared to other Russian regions. A total of 6.40 million people live on a 86 000 sq km size territory in the city of St. Petersburg and the province of Leningrad [19]. This population comprises a total of 4.5% of the entire population of Russia. The territory of the province of Moscow is 47 000 sq km and without the city of Moscow 6.47 million people live in the province, whereas the population is divided into 5.18 million people living in towns and 1.29 million people living in rural areas. The city of Moscow accommodates 8.54 million people. A total of over 15 million people live in the province of Moscow together with the city of Moscow [19]. The provinces of Leningrad and Moscow together with the cities of Moscow and St. Petersburg are rapidly developing Russian areas with high purchasing power.

Russian wastepaper market volume is estimated to be 9 million tons per year, from which 96% does to a waste dump. From collected wastepaper 3-4% is reused in Russia. In Moscow and the province of Moscow this figure amounts to 20% [20]. The Soviet Union, as well as Russia, has always produced a lot of waste, but due to historical reasons its reuse level has been low due to low priced natural resources.

Reusable material market with the total volume of 2-2.5 billion roubles (70-80 million USD) is viewed as one of the most rapidly growing markets in Russia. This comprises only 7-8% of the maximum market volume. In addition to wastepaper this includes 1.5 million tons of scrap metal, 2 million tons of polymers, 0.5 million tons of glass waste and 10 million tons of food waste [20].

Average Russian refuse and reusable material market volume increase is 8-10% per year [20]. The prices of reusable materials are low and these have been established for plants producing reusable materials through preparation/assortment of waste. There exists no competition and collection of reusable materials is performed on traditional markets like construction waste, wastepaper and glass. These markets are not able to have an impact on the prices of reusable material production in Russia. According to Russian analysts the solution lies in opening of alternative markets and their finding. Moscow together with the province of Moscow produces 260 000 tons of wastepaper and cardboard in a year (2005). The province of Moscow and the city of Moscow accommodate a total of 15 million people, which makes 17.3 kg wastepaper collected per person. Calculating this amount for the city of St. Petersburg and the province of Leningrad, where the population is 6.4 million, the market volume will be 111 000 tons of wastepaper per year. Hence, the market volume of two Russian large centres is 371 000 tons.

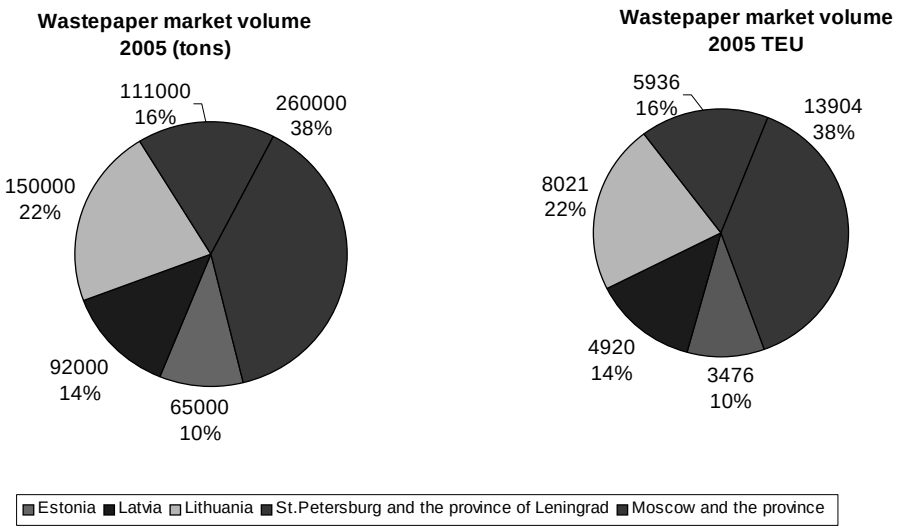

***Figure 3**. Wastepaper market volume of the Baltic countries, Moscow with the province and St. Petersburg with the province of Leningrad in 2005 (tons) [14], [20], [21]*

We see that the market volume of reusable wastepaper of Estonia, Latvia, Lithuania and the cities of St. Petersburg and Moscow, the provinces of Leningrad and Moscow totals to 678 000 tons. The share of the Baltic countries is divided as follows: Estonia 65 000 tons, Latvia 92 000 tons and Lithuania 150 000 tons. Considering the population of the Baltic countries the quantity of reusable wastepaper per person is the following: Estonia 49 kg, Latvia 41 kg and Lithuania 42 kg. Accommodating the corresponding amount of wastepaper into twenty foot containers on an assumption that one container accommodates 18.7 tons of wastepaper, the result will be market volume with the size of up to 36 257 TEU. Taken separately by countries from Russia 19 840 containers, from Estonia 3476, from Latvia 4920 and from Lithuania 8021 containers could be returned to China. From the Baltic countries 17 417 containers could be added to container transport returned to Asia.

Out of Russia's total container traffic in 2006 (2 400 000 TEU) the wastepaper volume of the Russian area in containers comprises an estimated of (19 804 TEU) almost 1% [29].

I assume that the total container transport volume in Russia (2 400 000 TEU) is divided into export containers 49% (1 176 000 TEU) and import containers 51% (1 224 000 TEU).

Based on the assumption that in 2006 Russia's total export container flow was 1 176 000 TEU, the share of containers returned for example to China with wastepaper forms 1.7 %. Considering the fact that at the minimum 48% of export container flow or 564 480 TEU includes empty containers [29], the share of export containers filled with wastepaper forms 3.5% of all Russia's empty export containers.

Calculating the potential wastepaper common market in containers provided in calculations (TEU) separately for three Baltic countries in percents into container traffic volumes of Estonia, Latvia and Lithuania we will get the following results:

In 2006, Estonian total container traffic volume amounted to 152 399 TEU and the common wastepaper market volume (36 527 TEU) would in such a case comprise almost 24% of Estonian container traffic volume.

In 2006, Latvian container traffic volume was 199 267 TEU and the analogous figure is 18.1%. In case of Lithuanian 2006 container traffic of 231 548 TEU the analogous figure is almost 16%.

Estonia, Latvia, Lithuania, Moscow, St. Petersburg together with provinces is the areas with rapidly increasing consumption. Together with increase in the economic growth of the countries also people's income will increase. By economic growth of countries Russia is not a country with most rapid growth (GDP growth – 6,6%), but this economic growth is sufficiently big for Russia's retail trade to grow from 245 billion USD in 2006 to 526 billion USD in 2010. Thereby foodstuff retail trade will grow from 113 billion USD to 203 billion dollars during the same period. An important contribution into the commodities sold in Russian retail trade comes from China, which export to Russia in 2006 increased by 19.8% or amounted to 15.8 billion USD compared to 2005. Chinese export commodities for Russian retail trade are transported to Russia in containers.

Compared to 2005, in 2006 Estonian retail trade increased by 19.1% and the respective figure for Lithuania was 7.3%. With it's approximately 20% increase in retail trade Estonia is not the most rapidly growing Baltic country. This title is captured by Latvia, whose retail trade in 2006 increased by 27.2% compared to 2005.

5. INCREASE OF CONTAINER TRAFFIC IN RUSSIA

Container traffic in Russia is rapidly increasing and substantial increase is also forecasted in the long-run. It may be stated that growth in Russian container traffic is an irreversible process, where the lack of port capacities in Russia will become an important appointer. There has been a lot of talk about rapid developing of new possible projects, for example in Ust-Luga and rapid developing of functioning ports, for example in Port of St. Petersburg. Yet, in reality Russian container traffic market grows faster than port capacities in Russia. This provides a possibility above all for the ports of the Baltic countries to get a share in the growing Russian container flow.

It is important for container flows to be balanced in both directions. As the biggest increase of container traffic to Russia originates from China in the form of commodities sold to Russian retail trade, also the flow of empty containers back to China will. One possible export article is wastepaper. Wastepaper is collected in Russia as well as Estonia, Latvia and Lithuania. Surely wastepaper

collection and its directing into reuse will develop in all three Baltic countries and Russia during years. Wastepaper market in these countries keeps growing rapidly, as consumption grows and refuses storage prices rise. This in turn requires more sorting of wastepaper.

Here also the Baltic countries and Estonia have a possibility for example in the face of wastepaper export to become an important transit channel for containers imported to Russia and exported from Russia. Also, the potential wastepaper market of the city and province of Moscow and the city of St. Petersburg and province of Leningrad can be added to the wastepaper market of the Baltic countries. These are the areas, where the majority of Russian import containers are directed to, which in turn need export commodities for sending these out of Russia. It is also important that import containers are directed to areas in Russia, from where it is possible to collect commodities to be returned in containers.

Wastepaper export in Russia is also favoured by the price of transport, which for example in case of container traffic from Estonia to Moscow by auto transport already includes the price of return transport of the empty container. Rail transport of a full container to Moscow and back to Estonia has to be paid for in both directions, but is altogether 25% cheaper than auto transport. Yet, in such a case there shall be wastepaper collection, sorting and container loading points in railway shunting yards in Moscow. In case of auto transport such warehouses may have different locations, as auto transport is logistically more flexible. In addition to this auto transport to Moscow is 3.5 times faster than rail transport. Sending of a container to Moscow by using auto transport takes up to two days, by rail transport up to a week.

Let's analyse potential volumes of the wastepaper markets of Estonia, Latvia, Lithuania and the city and province of Moscow and the city of St. Petersburg and the province of Leningrad. Let's do it by using the example of Finland, where 162 kg of wastepaper per one person is collected in a year. Now let's use the given quantity at the considering of a perspective wastepaper market in 2014 based on the number of population of the given countries and present the results in tons as well as recalculated in containers.

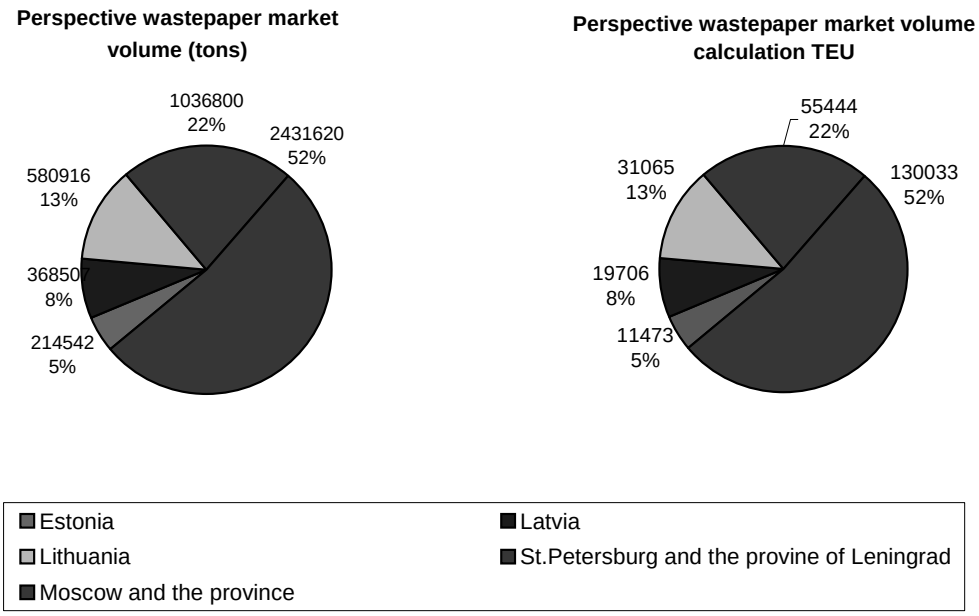

***Figure 4**. Perspective wastepaper market volume of the Baltic countries, Moscow together with the province and St. Petersburg together with the province of Leningrad in 2014(tons, TEU) [14], [9]*

Using calculations we get 4 632 385 tons as the wastepaper perspective common market volume. Let's calculate the given market volume into containers as a result of which we will get the results presented on the graph. Potential common market volume in containers is 247 721TEU. Let's recall that in 2005 Port of Los Angeles exported 165 813 TEU of wastepaper, hence this is a market volume to be taken seriously also in the future.

I assume that the total Russian container traffic volume (2 400 000 TEU) is divided into export containers 49% (1 176 000TEU) and import containers 51% (1 224 000 TEU) [29]. Using the

assumption that in 2006 the total Russian export container flow was 1 176 000 TEU, the share of containers returned to China with wastepaper will constitute 21% based on present volumes. Considering that at least 48% of export container flow includes empty containers (564 480 TEU) [29], the share of perspective common market export containers filled with wastepaper forms almost 44% of all Russian export containers. Calculating the potential wastepaper common market in containers (TEU) provided in calculations separately in percents for three Baltic countries into container traffic volumes of Estonia, Latvia and Lithuania we will get the following results: in 2006, the Estonian total container traffic volume was 152 399 TEU and adding common wastepaper market volume (247 721 TEU) Estonian container traffic volume would increase by almost 163%. Adding wastepaper common market container volume to export transit container traffic, growth would even amount to 2030%. In 2006, the total Latvian container traffic volume was 199 267TEU and adding wastepaper market volume growth would be 124%. In case of Lithuanian container traffic volume of 231 548 TEU in 2006, the analogous figure will be almost 107%.

CONCLUSIONS

Due to increase in container traffic volume in Russia also container traffic through three Baltic countries increases. Growth of Russian import container flow is principally based on containers transported from China. Compared to 2005, in 2006 increase in Russian import trade with China was 19.8%. Russia in turn exports oil, oil products and other energy carriers and fertilizers to China. In 2006, Russia exported 21.4% of oil products and 8.4% of fertilizers through Port of Tallinn, whereas almost 3% of Russian fertilizer export was transported through Port of Tallinn to China. Compared to 2005, in 2006 total Russian export to China increased 10.5%. Hence, trade between Russia and China keeps growing steadily. Both countries wish to meet the set target starting from 2004 to take trade from 30 billion USD to 80 billion USD in a year during the period of five years. For this extensive export articles have to be found for containers returned to China. As commodities imported in containers from China to Russia are directed to areas, where retail trade and purchasing power increase most rapidly wastepaper is a suitable export article. Consumption in Russia is largest in Moscow and the province surrounding the city and in St. Petersburg and the province of Leningrad.

As majority of container transport is performed in different ports, like for example in Los Angeles to the extent of 72%, in St. Petersburg to the extent of 95%, in Hamburg to the extent of 67% and in Tallinn to the extent of 93% using auto transport, it is expedient to use auto transport also at the transportation of wastepaper. For example upon transporting a container from Estonia to Moscow and back using auto transport, transport of an empty container has already been included in the price. Rail transport is cheaper, but auto transport is 3.5 times faster and logistically more flexible. Auto transport is also favoured by the fact that wastepaper collection warehouses are not converged around shunting yards in Russia.

Wastepaper export from Russia to China is also supported by a large wastepaper market in rapidly developing areas with dense population of Moscow and the province of Moscow and St. Petersburg and the province of Leningrad. Presently Russian potential wastepaper export market volume amounts to 371 000 tons or calculated into containers a total of 19 840TEU, which forms 3.5% of the transport volume of Russian empty export containers. The wastepaper export market volume of Estonia, Latvia and Lithuania is 307 000 tons or 16 417TEU. The perspective wastepaper export common market volume is 4 632 385 tons or 247 721TEU in 2014, using Finnish statistics at the collection of wastepaper per one person in a year.

As a result of trade between China and Russia there will emerge an amount of empty marine containers to be returned to China that can be used at the export of reusable wastepaper into Asia.

As Port of Tallinn has experience as a port servicing Russian export, we have a possibility to become also the tender of Russian import and export containers. For this we should be able to organize wastepaper export from Russia and the Baltic countries through Port of Tallinn into China. Growth of import in China was 15.3%, constituting a total of 23.5 million tons and it was the largest wastepaper importer of the world in 2006. Increase of Chinese import during the past five years of 285% clearly indicates a growth trend and a possibility for Estonia to be an extensive exporter of wastepaper into China.

At the launching of the reusable materials plant Estonia can include additional transit container flows from China into the largest port in the ownership of the state – Port of Tallinn. This in turn

enables to construct terminals supporting additional container transport and creating additional value in the port and creates additional volumes for rail transport and the entire transit chain.

There are companies having experience and know how to launch a reusable materials plant together with central wastepaper collection in Estonia. Reusable materials plant would service wastepaper volumes collected from Estonia, Latvia, Lithuania and major Russian cities and provinces and process wastepaper into reusable wastepaper.

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ESTIMATION OF ECOLOGICAL RESOURCES, CAUSED BY INFLUENCE OF CITY TRANSPORT

Stanislav Grishin, Eugene Kopytov, Oleg Shchiptsov

Transport and Telecommunication Institute
Lomonosova 1, Riga, LV-1019, Latvia
Phone: (+371)7100650. Fax: (+371)7100660
E-mail: ctac@tsi.lv

Researches, forced to solving transport problems, are relative. First of all because the crisis condition in security and ecology in big and medium cities is caused in many cases. The crisis condition is caused by rapidly increasing number of traditional types of transport and different buildings for its service. By that risk for human health, animals and green areas also increases many times because of air pollution and other factors.

In the article the necessity of estimation of ecological risks, connected with city transport influence is shown. Ways of mathematic models processing, terminology and ecological risk index are offered, including theory of probability, considering accumulation of changes in system. In using theory of probability with changes in system mathematic models for estimation of ecological risk in system with two conditions, many conditions and also for case for estimation of accumulating ecological risks are offered.

Keywords: transport ecology, changes, storing changes, risk, system, favourable and unfavourable condition

1. INTRODUCTION

The researches, forced to solving transport problems, are relative. First of all crisis condition in security and ecology in big and medium cities is caused due to many cases. The crisis condition is caused by rapidly increasing number of traditional types of transport and different buildings for its service. By that human health, animals and green areas risk also increased many times because of air pollution and other factors [1, 2]. CO concentration in the air, caused mainly by transport exhaust, in Paris is 200 mg\m^3, in London 300 mg\m^3, in Rome 565 mg\m^3. In USA 50 000 people die every year because of diseases, caused by transport exhausts. That is where the saying comes from: "Transport suffocates more than knocks down". Air quality destructing in the cities harms not only people health but also affects flora and fauna, ruins culture monuments and city buildings. Many toxic substances from exhausts not only run into the air, but also expand to long distances.

For liquidation of pollution consequences Great Britain spend 100 million pounds a year, USA – 1, 5 milliard dollars, Japan – 700 milliard yens. In USA it is concerned, that clean air could help to economy 2 milliard dollars a year on medicine. Speaking about risks for human beings and nature, connected with transport pollution, we cannot not to point on influence of noise, vibration and electromagnetic radiation. It affects nerve, digestive systems and leads to nerve and stomach diseases, loss of audition and other negative consequences. It all causes a necessity of considering risks, connected with transport connection.

Ecological risks in city systems caused by transport influence can be estimated in connection with some parameters and changes in other systems. When the influence is negative enough to be out of general parameters limit, connected with standard ecology norms, the risk of unwanted changes in human organism, buildings and other systems comes up. Change or totality of changes in system can lead to the end of its existence (organism death, buildings ruin etc.)[3]. Thus the risk of surplus any approximate limits may have a catastrophic consequences for any system. When such changes come up there formats a threat which can lead to loss in system or even to death. But risk is an inevitable satellite not only for transport ecology. There is risk in any anomaly of economics (economic risk), in weather conditions (meteorological risk), metrological risk at inaccurate metering, etc [4]. During estimation of ecological risks in the city we face with short of serious scientific researches at processing mathematic risk models, terminology and risk index [1, 5].

Let us call the risk of transport ecology a possibility of loss in system (for example, for human being) because of changes or complex of changes coming up in system if a standard limit is surplus. Risk of increasing level of limit is an adventure. It is an adventure for two reasons: randomness of

changes coming up which leads to increasing the limit and randomness of loss amount (for example, human organism does not always die but healing takes time and investment). We can use this characteristic for estimation of risk – mathematical expectation [6, 7].

Let us look through the problem with estimation of risk for system with two conditions, for system with many conditions and for system with case of storing changes.

2. ESTIMATION OF ECOLOGICAL RISK FOR SYSTEM WITH TWO CONDITIONS

For human organism (or for another system) there is no risk if some of its parameters X do not contravene the limit X_{lim}. This term can be shown in the following way

$$X \le X_{\lim}. \tag{1}$$

It means that there is a favourable condition. In a favourable condition it is concerned that human is actually healthy.

Both rates are usually considered as determinates, but actually they both are random. So that rule (1) exists only with partial possibility

$$P = p\left(X \le X_{\lim}\right).$$

If

$$X > X_{\lim}, \tag{2}$$

then it means coming up of unfavourable condition. It comes with possibility

$$Q = 1 - P = p\left(X > X_{\lim}\right).$$

Unfavourable condition is caused by changes in system. For example, human gets a cold. It can lead to loss in system (expenses for medicine) or even to its destruction (death). Let us sigh with *C* maximally possible loss if parameter X >X_{lim}. Real matter of loss can be any number which can be zero with possibility *P* and *C* with possibility *Q*. Then

$$D=C\cdot Q \tag{3}$$

characterizes medium loss (medium risk).

We can estimate the possibility of unfavourable condition *Q* if we know the rules about sorting random *X* and X_{lim}. Sorting them with formula $f_X(t)$ and $f_{X_{\lim}}(t)$ and we have [6]

$$Q = \int_{-\infty}^{+\infty} \overline{F}_{X_{\lim}}(t) f_X(t) dt,$$

where

$$\overline{F}_{X_{\lim}}(t) = \int_{t}^{\infty} f_{X_{\lim}}(x) dx.$$

If random *X* and X_{lim} can be normally sorted (it usually takes place in practice) with parameters (m, σ) and (m_{lim}, σ_{lim}), then mathematical sum of these random number also can be normally sorted and have probability

$$Q = \frac{1}{2} + \Phi\left(\frac{m - m_{\lim}}{\sqrt{\sigma^2 + \sigma^2{}_{\lim}}}\right),$$

where $\Phi(t) = \frac{1}{\sqrt{2\pi}} \int_0^t e^{-\frac{x^2}{2}} dx$ show Laplase function. By using formula (3) if we know m, $m_{\lim}$ then with Laplase function table we can estimate the medium risk. To put it in other way, medium risk in system is an expression with loss in unfavourable conditions and probability of that condition.

3. ESTIMATION OF ECOLOGICAL RISK FOR SYSTEM WITH MANY CONDITIONS

We regard that system does not have only one unfavourable condition but several. For example, human gets ill in case of different dips of arterial pressure, density of pulse, organism temperature norms, etc. It means that different dips of norms can take part in organism – one, two, three, etc. parameters. Let us point the amount of conditions as E like E_1, E_2, ... , E_n. Now let us divide the amount of conditions E in two amounts which we will consider as un-crossable or $E = E_+ \cup E_-$, where E_+ – the amount of favourable conditions and E_- – the amount of unfavourable conditions. $P_i(t)$ – probability of case, where system is in condition E_i, where i = 1, 2, …, n. C_i will be the amount of loss, caused by reducing from favourable conditions E_+ to unfavourable conditions E_-. It must be mentioned that we exclude the possibility of E_- amount turning into E_+ amount.

Using formula of absolute probability [6, 7], we get estimation formula for average risk of the system:

$$\mathrm{D}(\mathrm{t}) = \sum_{E_i \in E_-} C_i \cdot P_i(t). \tag{4}$$

For example, if the system has only three conditions E_1, E_2 , E_3, where E_1 is favourable, but E_2 , E_3 – unfavourable, then according to the formula (4) total risk of the system can be estimated by formula:

$$\mathrm{D}(\mathrm{t}) = C_2 P_2(t) + C_3 P_3(t).$$

Let us loss C_2 characterize for example losses caused by heart attack or lungs diseases, but loss C_3 – losses, caused by nerve overload. The first change in organism may cause huge losses while the second one will cause just a few discomforts for organism.

We can also give a little bit different interpretation of risk in connection among probabilities of system acting in conditions and average number of reducers between conditions:

$$P_i(t) = \sum_{E_j \to E_i} M_{j,i}(t) - \sum_{E_i \to E_j} M_{i,j}(t). \tag{5}$$

Here the probability of $P_i(t)$ of condition E_i is a sum of two items. First item characterizes total number of reducers $M_{j,i}$ from all conditions E_j into the given condition E_i (it comes with character «+»). The second item characterizes total number of reducers from the given condition E_i into all the other conditions E_i (it comes with character «–»).

In case when system works till getting in unfavourable condition and does not get out of it, it is said that the system has got into absorption condition. Absorption condition for a human is chronic disease or death. If E_i is an unfavourable condition and it has no reducers in other conditions then formula (5) for probability $P_i(t)$ gets easier:

$$P_i(t) = \sum_{E_j \to E_i} M_{j,i}(t) = \sum_{E_j \in E_+} M_{j,i}(t). \tag{6}$$

After using (6) in formula (4) we get formula of risk, which is similar (equivalent) to formula (4):

$$D(t) = \sum_{E_i \in E_-} C_i \sum_{E_j \in E_+} M_{j,i}(t). \tag{7}$$

It means that average risk of the system is equal to sum of losses of reducers in each unfavourable condition formulas, multiplied by total average number of reducers in that condition.

In case when system gets in unfavourable condition but can change it in other unfavourable conditions (one changes (diseases) cause the other, more dangerous ones), it has no possibilities to get back in favourable conditions. In that case, by using (4) and (5), we get the following formula for an average risk:

$$D(t) = \sum_{E_i \in E_-} C_i \sum_{E_j \in E_+} M_{j,i}(t) + \sum_{E_i \in E_-} \sum_{E_i \in E_-} (C_i - C_j) M_{j,i}(t). \tag{8}$$

Here the first item matches with (7) but the second item is completely connected with processes of reducers in number of unfavourable conditions. Besides, the second item is zero if losses $C_i = C_j$ (the same for each unfavourable condition) for any E_j, $E_i \in E_-$. In that way if all unfavourable conditions are similar formula (7) can be used for estimation of risks by losses. Formula (8) should be used in case if unfavourable conditions differ by losses. It usually happens when a condition with more harmful consequences for organism follows conditions with more trivial consequences for system.

For example, if unfavourable condition E_2 leads to unfavourable condition E_3 with bigger losses ($C_3 > C_2$), as also a reducer in unfavourable condition E_4 from favourable condition E_1, then according to formula (4):

$$D(t) = C_2 \cdot P_2(t) + C_3 P_3(t) + C_4 P_4(t)$$

and according to formula (8)

$$D(t) = C_2 \cdot M_{1,2}(t) + (C_3 - C_2) M_{2,3}(t) + C_4 M_{1,4}(t).$$

4. ECOLOGICAL RISK WITH ACCUMULATION

If reducers from unfavourable conditions to favourable are impossible then many of unfavourable conditions are ergonomic. It is right with the systems (organisms) which do not regenerate (heal). In case of system regeneration it starts function again but there is a possibility to get in unfavourable condition with risk of loss again. As a result the sum risk of the system accumulates as the time passes. We will call such risk as a risk with accumulation.

In that case we remove limits on possible system reducers from many unfavourable conditions to favourable ones. The reducer from each condition may take several steps. We will call them displaying conditions but not absorption conditions anymore. In this case formula (4) cannot be used for estimation because there is no accumulation of risk function in it. But formulas (7) and (8) do not lose their meaning: the average number of reducers from condition to condition inevitably increases in time. So that accumulation of risk operates while the system is functioning. An average risk, accumulated by the system in time *t* is defined by formula (8), but in case with no reducers among unfavourable conditions – formula (7).

For example, in reducer from unfavourable condition E_2 to favourable condition E_1 in looked through system before in example with three conditions the accumulated risk by using formula (7) can be estimated:

$$D(t) = C_2 M_{1,2}(t) + C_3 M_{1,3}(t) = C_2 M_{1,2}(t) + C_3 P_3(t).$$

Let us mention that the first item in the given risk function with risk accumulation monotonous increases and can be any great figure.

Estimation of ecological risk, for example, for Riga city, the main factor of negative influence on human organism, fauna and flora is a transport factor. Probably in another city the main factor can be the industrial factor. In some cities both factors have more or less similar influence on ecological risks.

Discussed models, analytic access at estimation of risk considering transport factor are quite usable for two other cases mentioned before.

CONCLUSIONS

In this article the necessity of estimation of ecological risks, connected with city transport influence is shown. Ways of mathematic models processing, terminology and ecological risk index are offered, including theory of probability, considering accumulation of changes in system. In using theory of probability with changes in system mathematic models for estimation of ecological risk in system with two conditions, many conditions and also for case for estimation of accumulating ecological risks are offered.

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PRINCIPLES OF SUSTAINABLE MULTIMODAL URBAN PUBLIC TRANSPORT SYSTEMS

Gražvydas Jakubauskas[1], Ulrich Weidmann[2]

[1]Vilnius Gediminas Technical University, Faculty of Transport Engineering
Transport Management Department
Plytinės Str. 27, Vilnius, LT-10105, Lithuania
Phone: (+370)52745099. Fax: (+370)52745059. E-mail: Grazvydas.Jakubauskas@ti.vgtu.lt

[2]Swiss Federal Institute of Technology Zurich, Institute of Transportation Planning and Systems
Wolfgang-Pauli Str. 15, 8093 Zurich, Switzerland
Phone: (+41)446333350. Fax: (+41)446331057. E-mail: Weidmann@ivt.baug.ethz.ch

Multimodality is one of the key elements of efficient urban transport systems, bearing in mind that 80% of Europeans live in an urban environment; the need of efficient urban transportation systems is undisputable. Most means of public transport, private cars, lorries, cyclists and pedestrians all share the same urban infrastructure. The European Commission draws attention on 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 methods to increase mobility and at the same time to reduce negative effects of public transport (congestion, accidents, noise and pollution). The answer to that is a development of sustainable multimodal public transport system. In passenger transportation we describe multimodal journey as 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 switch seamlessly between transport types with limited waiting times and smooth transitions [2]. When we talk about sustainable multimodal systems, usually it encompasses both terms. Sustainable multimodality leads to a better productivity and attractiveness of urban public transport and positively influences people's mobility in an urban area**.**

Keywords: multimodal journey, single ticket system, TVM, P&R, B&R

1. INTRODUCTION

Models for sustainable development of urban public transport are unique to every single urban system. Depending on landscape, population, economic strength of cities, those systems have their own way for transport development of that is called efficiency of the system. Nevertheless, sustainability is a broader and omnibus term, described by many factors; amongst which the following ones are crucial when developing sustainable urban public transport system:

- Environmentally friendly transport system;
- Easy-to-use infrastructure and transport vehicles for all;
- Efficient transport system;
- Well-developed public transport network and interaction between private and public transport;
- Effective co-operation of stakeholders (private and public transport bodies).

These are the focal transport areas analysed in the article, amongst others. The latter concern issues not so closely related with transport planning issues as the ones listed above, but are nevertheless not less important, as for instance those analysed by civil engineers or city planners.

As a good practice example of multimodal urban transport which might be taken as a benchmark, the one of Zurich city is analysed in the article.

Theoretic model for a creation of a multimodal transport system of Vilnius city and practical general recommendations for sustainable development of an urban transport are provided in the article as well.

2. SUSTAINABLE MULTIMODALITY

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 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.

What concerns easy-to-use infrastructure, strong initiatives to encourage adaptation of infrastructure and vehicles for all users (passengers, drivers, and pedestrians), it has already found their place in practice. People with reduced mobility are the most vulnerable users; therefore advance solutions, as for instance tactile surfaces for visually disabled or special infrastructure for wheelchair-users is seen as a very important priority towards the seamless transportation for those people. Transport vehicles have accordingly to be constructed (electronic ramps, low floor vehicles, easy to use ticketing equipment and etc.)

Efficiency of transport systems must not be compared with only economic profitability. Transport, especially urban-suburban, renders social function and can not be profitable unless it does not fully ensure transportation needs for civic residents. Application of intelligent transport systems and services (ITS) provides wide possibilities for transport operators to reduce costs related to transport activities. ITS have been more and more successfully deployed in public transport systems, to improve main factors of transportation (those factors are analysed further).

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. 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 as well serves for international and national traffic. 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, bigger 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.

The scheme below illustrates a streamlined model of transport links.

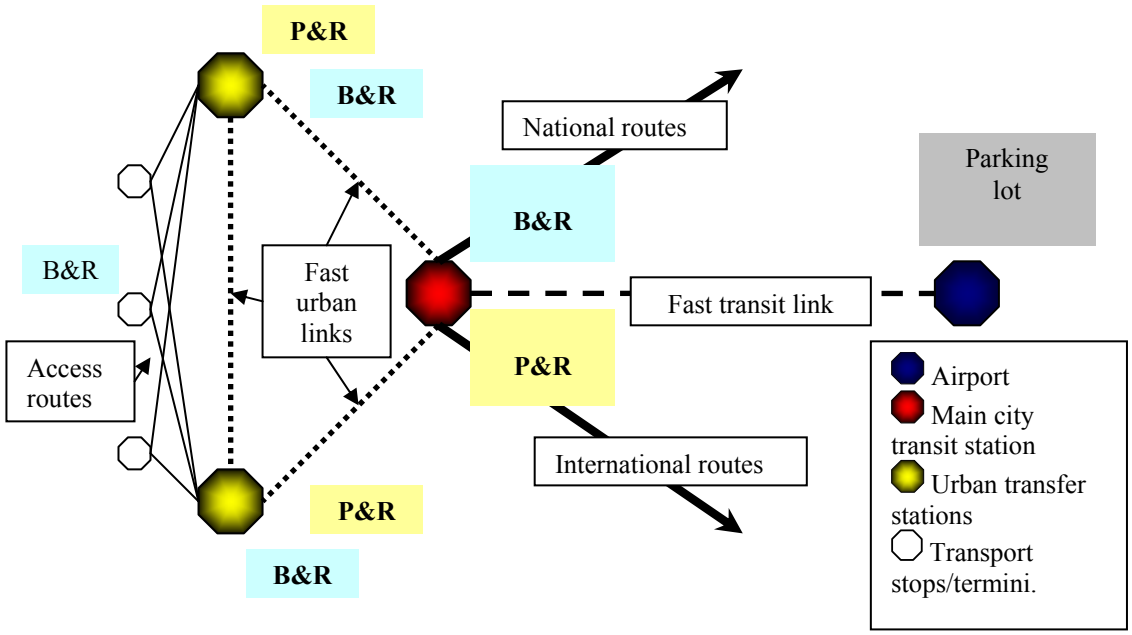

Figure 1. *Urban transport links*

Effective co-operation of stakeholders (both private and public bodies) lets involve all the parties concerned and participate in transportation (planning, financing) processes. Practical implementation of organisational structure of public transport system in canton of Zurich is thereinafter analysed in detail.

This notwithstanding, an ideal model is difficult to achieve: builders (operators) want to provide the smallest possible network (to minimize production costs) while users want to have the largest possible network (to minimize travel costs/time) [3]. Development of high quality urban transport is seen as a priority of the transport policy of European Union. White Paper of European transport policy proposes „to place the emphasis on exchanges of good practice aiming at making better use of public transport and existing infrastructure“ [4].

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) [5]:

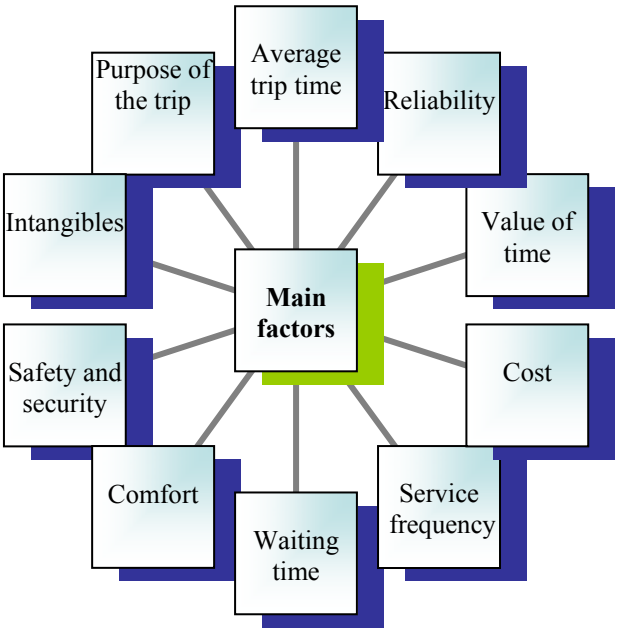

Figure 2. *Main factors influencing the choice of urban transport type*

It is difficult to distinguish the most important factors, as it depends on every single passenger needs. Nevertheless, in order to gain reasonable competitive edge, public transport has to offer (provide) sufficiently qualitative service comparing with private cars. Still, private cars might be of better choice depending on certain circumstances (mostly on a trip purpose) therefore efficient private-public transport interaction is needed as well.

3. ZURICH URBAN TRANSPORT SYSTEM – EXAMPLE OF GOOD PRACTICE

All public transport companies in the Canton of Zurich are linked together in the Zürcher Verkehrsverbund (ZVV). Role of this company is to provide a dense route network, frequent services at regular intervals and short waiting times for connections. It is also responsible for marketing and allocation of financial resources for service providers. ZVV has introduced integrated ticket systems – the so-called „One ticket for everything“ and well-developed user-friendly zone system with a standard tariff (uniform fare structure) that enables using all forms of transport with just one ticket.

Transport companies operating in the Canton of Zurich render their services on a fixed-term contract (which after its expiration has to be put to competitive bid). Contractors of ZVV have their subcontractors with less function (that provides no marketing functions, only plain transport services for contractors) (Fig. 3).

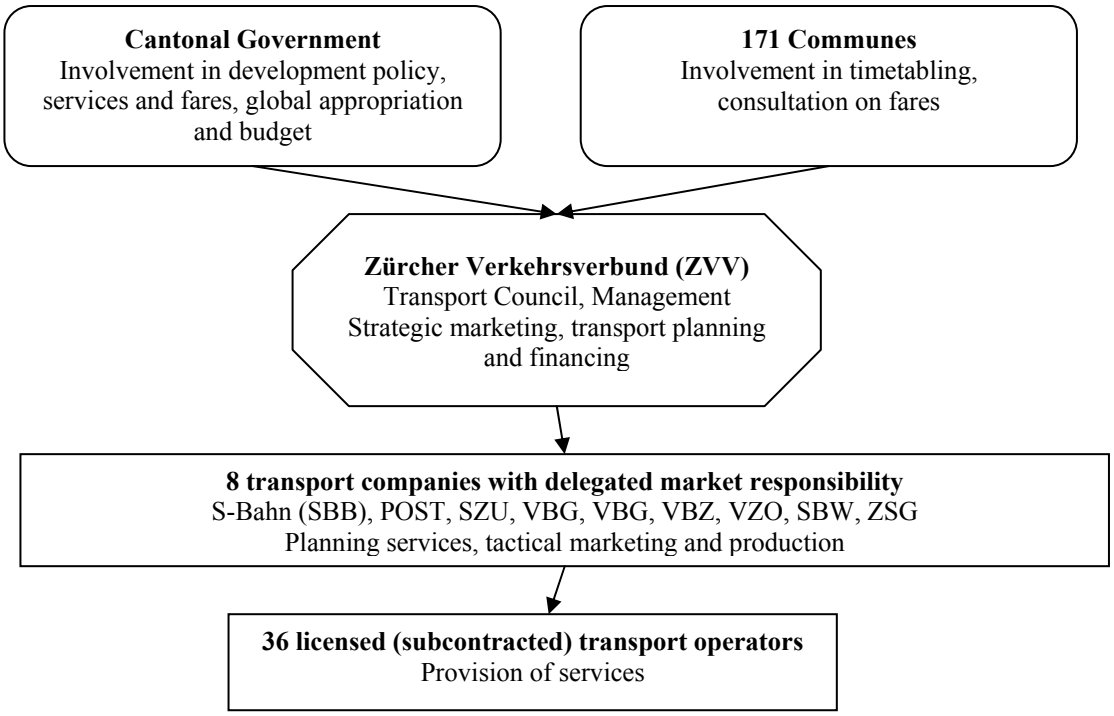

Figure 3. *Organisational scheme of public transport management in Canton of Zurich*

It is probably one of the most effective ways of organisational structuring: in many cases throughout the Europe, it became necessary for the public authorities to help finance transport infrastructure and even the operations in order to enable the service company to attain its profitability threshold. Yet, sufficient incentives must still be in place to ensure that the operator is optimising its level of performance. The primary role of the public authority lies in the area of system regulation to verify that the public service is indeed provided under optimal conditions. [6]. Despite the fact that everybody aims at reaching these optimal conditions, provision of public transport services leads to inevitable deficit. In a case of the ZVV, company's deficit has remained more or less constant over the last 7 years and has been financed equally (50 per cent) by Canton and Communes.

ZVV focuses on both urban/suburban and regional public transit providing well developed solutions on modal choice, timetables frequency, transport fares and related infrastructure. This enable sustainable transportation processes throughout all the area of Canton of Zurich. The concept of integrated urban-suburban-regional transport is being implemented widely in the most Western European cities as well and has proven its advantages.

8 transport companies are contracted by ZVV to provide their services with delegated market responsibility. Duties of these companies encompass compilation of detailed timetables, contacts with communes in Canton of Zurich, operating their own services (buses/trolleybuses, ships, funiculars, boats, trams, railway), management of other operators (subcontracted transport companies), advertising for the market area and supervision of centralised ZVV duties.

Other 36 transport companies are subcontracted by these 8 companies and have no market responsibility. Their duties encompass mainly on transport services on rail, bus and boat routes. As subcontractors, these companies have no influence on timetable. Those companies make an annual agreement with their contractors on an annual agreement on remuneration, the level of the latter is independent of the ticket receipts obtained and the number of passengers carried (no allocation of revenues) and are obliged to respect minimum conditions of employment. According to customer survey results (which are carried out every two years), these companies might get bonuses for the quality of service.

After a referendum in the 1970s, in which Zurich inhabitants rejected a proposal to build an underground metro system, the city has focused on its environmentally friendly transport means, while easing off the city-centre streets from most cars. Tram network is one of the densest in Europe, fast bus and trolleybus routes are used as access links from suburban termini to outlying districts. S-Bahn

suburban trains, most originating from or passing through the main station, add a third dimension, linking to Zug and Einsiedeln in the south and Winterthur, Schaffhausen and Stein-am-Rhein in the north, as well as serving the nearby Uetliberg summit. Boats and funiculars complement multimodal choice as well. On Friday and Saturday nights, night transport provides services from centre of Zurich to various suburban destinations. Network of bicycle lanes, bearing in mind the mountainous landscape of Zurich, is quite well-developed, and excellent parking facilities for bicycles, mopeds and motorbikes are provided. Main railway station has bike-rental facilities, furthermore – Zurich is also one of the cities offering free bikes ("Züri rollt") for 20 Swiss francs returnable deposit on production of ID. There are six locations of "Züri rollt" terminals in Zurich, where one can take ordinary bicycle, as well as electric-bike or scooter (daily 7.30am–9.30pm). Tourist transport terminal is just outside the main railway station and parking lot for private cars. Opposite to the main railway station are located "Mobility" parking lot. "Mobility" concept (train-car) is a product of railway company SBB, when subscriber of the programme can use "mobility" cars in more than 1000 stations in Switzerland not having to use his/her own car, but encouraged to make long trip by train and reach the destination by "mobility" car taken from the station. Canton of Zurich has also a very well-developed urban/suburban rail system (S-Bahn). Introduced in early nineties, "S-Bahn" has more than doubled number of passengers carried since opening of the network: from 159 thous. passengers a day in 1990 to 332 thous. in 2006 (not counting EC/IC/IR trains on south bank of Zurich). In conclusion, central public transport terminal – Zurich's main train station (Haupbahnhof) is well-linked by almost all means of transport, used in Zurich (Fig. 4).

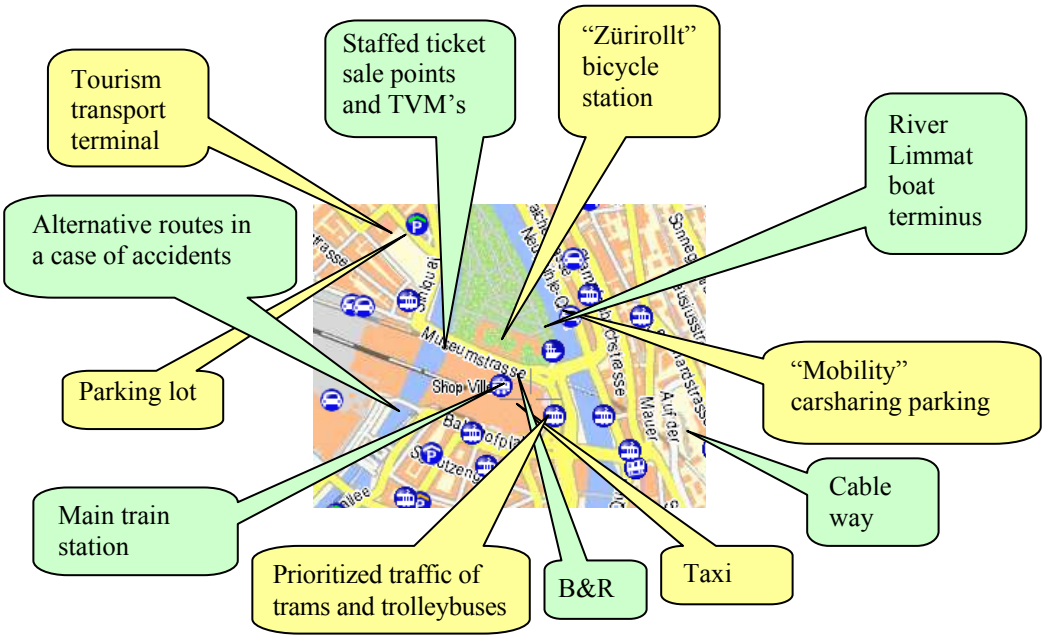

Figure 4. *Transport links and transport-related infrastructure in centre of Zurich*

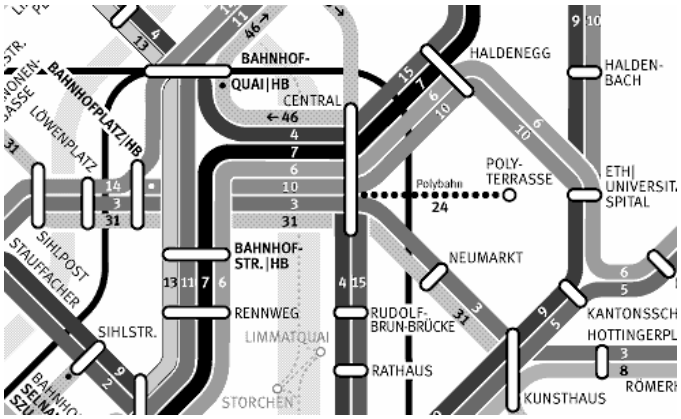

Figure 5. *Transport links to and from the centre of Zurich*

The scheme below highlights the main features of Zurich urban transport system that might be considered as backbone for seamless transportation and main preconditions towards sustainable multimodality.

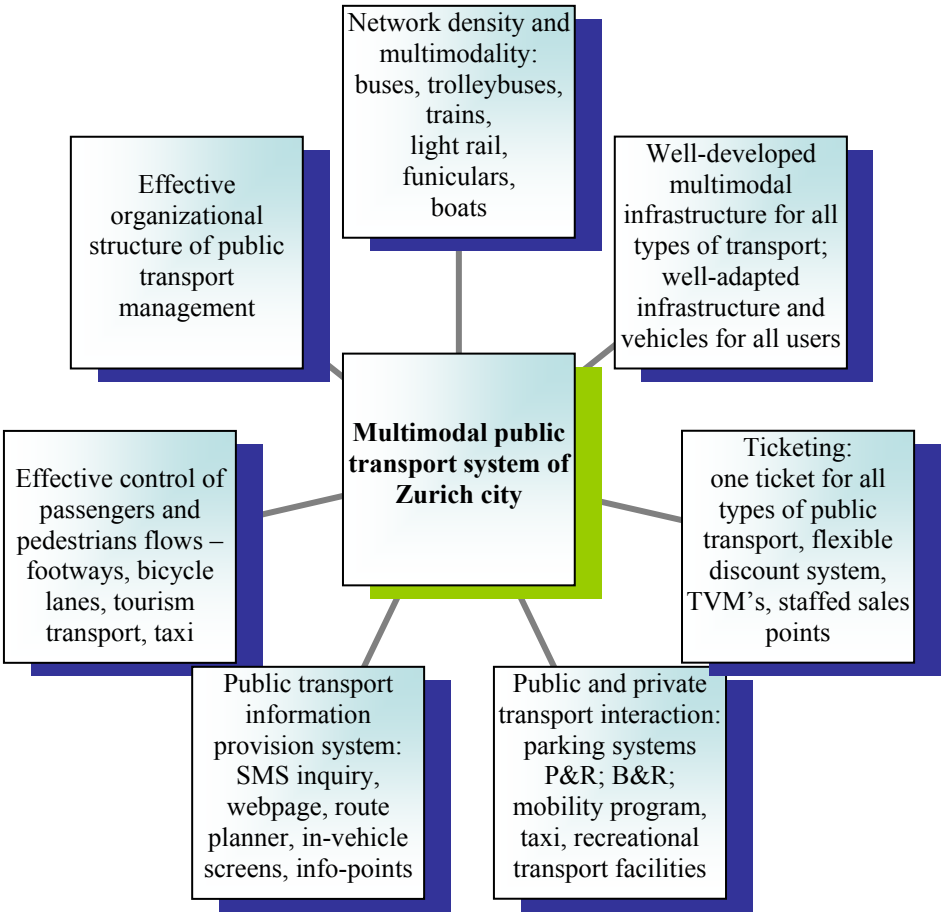

Figure 5. *Transport links to and from the centre of Zurich*

4. RECOMMENDATIONS FOR IMPROVEMENT OF VILNIUS TRANSPORT SYSTEM TOWARDS SUSTAINABLE MULTIMODALITY

Analysing the main drawbacks of the urban transport system of Vilnius it needs to be emphasized the lack of transport multimodality and sustainability. Mainly due to fast economic growth of the city, that lead to spreading out boundaries and natural change of traffic flows, urban transport system has became less sustainable and unable to serve need of passengers effectively. Present system due to insufficiently developed bicycle network, lack of high-speed transport means, congested streets, insufficient urban/suburban rail links, different tariff and ticketing systems is not functioning as a sustainable and multimodal entity.

Urban transport network of Vilnius is served by 19 trolleybus routes (259 trolleybuses, network of 456 km, 400 thous. pass. transported a day), 75 bus municipal bus routes (network of 1634 km, 295 buses, 298 thous. pass. a day), and dedicated routes for private microbuses and buses. There are few suburban railway lines which only weakly serve for an urban transportation needs, therefore often are not being considered as urban transport at all. Table 1 indicates some basic technical features of different types of transport in Vilnius.

Table 1. Comparison of technical features by transport type

Mode/type	Ticket system	Operator	Information provision	Fare
Buses	Common	JSC "Vilniaus autobusai"	SMS query, WAP, WWW, timetables	1.10 LTL
Trolleybuses		JSC "Vilniaus autobusai"		
Microbuses	Company's own system	Private companies	Not developed.	3 LTL
Private buses		Private companies		0.8 LTL – 1.5 LTL
Trains	Own	JSC "Lithuanian railways"	Timetables, website.	Depends on distance travelled

Prof. J. Butkevičius proposes a set of complex measures for modernisation of the present transport system in the biggest Lithuanian cities [7]. Of the most urgent importance for Vilnius city might be listed the following measures:

- Developing the public transport priority systems;
- To introduce modern uniform fare system;
- Introduce Park and Ride system;
- Improve information provision system;
- Introduce a modern high-speed means of public transport;
- Better integrate all public transport means and types.

Constantly growing number of passenger cars in street Vilnius shows inefficient utilisation of cars (less that 2 pass. of cars). Nevertheless, lack of fast urban transport links and lack of high-speed urban transport mode make present system not capable to stop the growing number of private vehicles. Big concern is reliability of transport (punctuality), especially in peak hours. More detailed picture on the present situation and recommendations are provided in the Table below:

Table 2. Recommendations towards sustainable multimodal transport in Vilnius

Sustainability factors	The present situation	Recommendations
Environmentally friendly transport system	Dense and well-developed network of trolleybuses. Pilot projects for bio-fuels promotion. Renewal of bus and trolleybus fleet.	To create well-balance multimodal system with eco-means of transport for fast transit.
Easy-to-use infrastructure and transport vehicles for all.	Lack of systems for people with reduced mobility. Lack of infrastructure-based and in-vehicles intelligent transport systems. Introduction of electronic tickets (in 2007), increase of low-floor vehicles. Difficulties with seamless transportation.	Improve access to public transport for handicapped people. Introduce ticket vending machines (TVM). Develop priority systems, intelligent traffic light system. Implement intelligent information provision (real-time information) systems.
Cost-efficient transport system	Majority of passengers fall to preference category. However, overall utilisation of vehicles is very high.	Different ticketing system, absence of uniform transport fare.
Public transport network and interaction between private and public transport	Lack of private-public interaction systems. Underdeveloped bicycle infrastructure network. Absence of light rail or other high-speed urban transport. Rail network is not integrated into urban system.	Introduce high-speed urban transport. Start to utilise river transport potential, implement B&R, P&R systems. Improve parking situation for skyrocketing tourism transport.
Co-operation of stakeholders (private and public transport bodies	Lack of co-operation between municipal and private operators. Lack of common elements (ticketing, information provision, etc.)	To involve all the main transport operators into a common transport planning process. To create more convenient ticketing system.

Lack of high-speed urban transport (which are usually the most reliable transport means), causes severe problems: first of all in a city with around 600 thous. inhabitants, who moreover is not concentrated but rather spread out significantly farther its past boundaries, the need for fast, comfort and high-speed means is obvious. Having no fast urban links and no rail link to the main airport of Vilnius, citizens greatly favour private microbuses. Nevertheless, the capacity of the passenger transport network is close to its maximum and growing congestion, caused by not very effectively used private cars might anticipate overloading of urban infrastructure.

The picture below illustrates urban links in Vilnius.

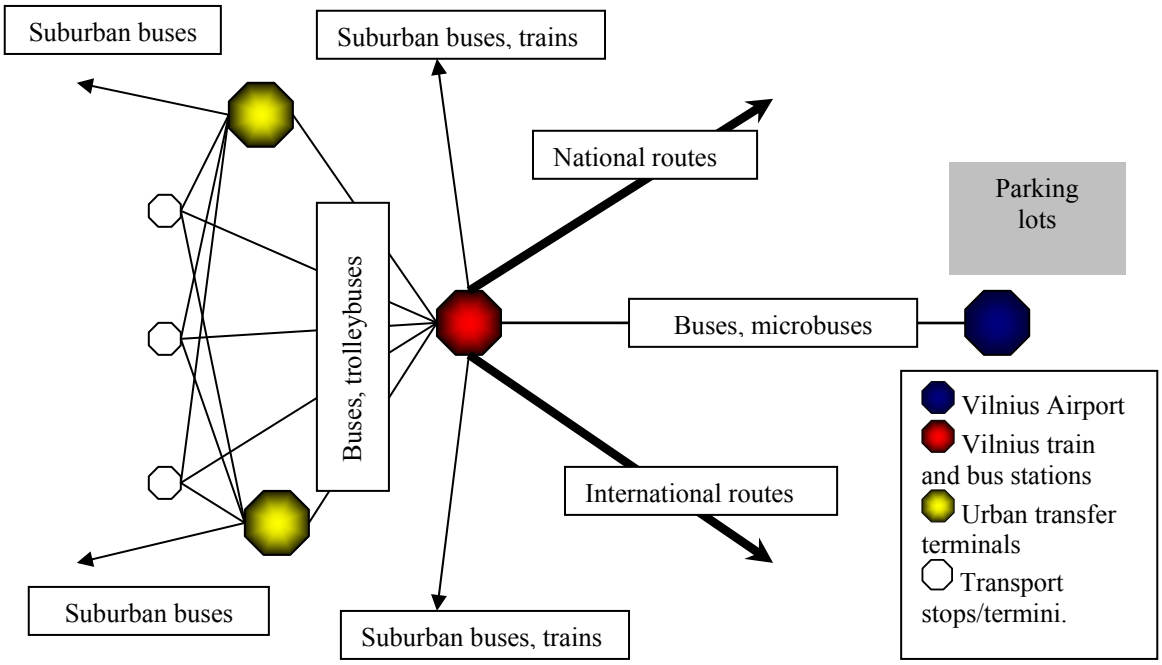

Figure 6. *Urban transport links in Vilnius*

Vilnius railway station and closely located bus station both form the main passenger transport node. Urban transfer terminals are relatively small, main links stretch from city station area. Lack of bicycle infrastructure and P&R zones lessens options for reaching urban transfer terminal to change mode from private cars to public transport.

CONCLUSIONS

1. Private and public transport interaction systems, e.g. P&R (park and ride), especially at vicinities of the city help to avoid congested street and promotes the use of public transport. B&R (bike and ride) option is seen an attractive as the way to access the nearest public transport terminals, where landscape is favourable.
2. Involvement of urban transport stakeholders must ensure that all of them participate in management of transport systems in a co-operative way. "Umbrella" structure, as implemented in Canton of Zurich, leads to better utilisation of multimodal system.
3. Implementation of intelligent transport systems and services greatly affects all the factors influencing urban journey and leads to sustainable functioning of multimodal urban transport systems.
4. Organisational structure has to ensure that transport managers and operators know passenger need and get feedback constantly to be able timely react.

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TRANSPORT INFRASTRUCTURE AND INFORMATION TECHNOLOGIES DEVELOPMENT OF THE LITHUANIAN

Ramunas Palsaitis

Vilnius Gediminas Technical University
Plytines Str. 27, Vilnius, LT-2016, Lithuania
E-mail: trvadyba@ti.vgtu.lt

The transport infrastructure development and modern IT implementation in transport sector are very important for the effective cargo and passengers' transportation and effective control of traffic flows. The main aim for implementing the contemporary IT in transport sector to provide all transport service suppliers and customers with operative information in the most convenient and precise way for respective services to gather and process statistical information, that could enable all transport related institutions and organisations to utilise the data in analysing, forecasting and passing decisions with regard to transport operations.

Keywords: transport infrastructure, information technologies, traffic flows, information technologies

1. INTRODUCTION

The transport sector plays an important role in the economy of Lithuania. Its contribution to GDP has increased consistently during recent years and in 2006, transport's share of GDP was 9,6 per cent.

In 2006 504 million passengers were transported by public transport (387 mln. by road transport), 105,8 mln. tons of freight were carried by roads and railways (56,5 mln. tons by road transport). All of this requires a comprehensive transport system, which is in Lithuania composed of 79 thousands roads (21,3 state roads), 1 775,1 kilometres of rail tracks, Vilnius, Kaunas and Palanga airports for international passenger and goods transport, Klaipeda sea port for international freight and passenger transportation by sea.

The demand for cargo and passengers transportation during the last six years is rising and the consequences are reflected in an overburdening of parts of the transport network and an imbalance in the overall transport infrastructure.

Information and communication technologies in the transport sector are not enough developed and exist quite big retardation from old EU countries. In Lithuania is implemented the automatic traffic data collection system on motorways, which provides information about driving conditions on roads drivers can get from TV text page and very soon the Road Transport Directorate is planning to have page about traffic jams, roads surfaces and driving conditions on the Internet.

A transport policy represents the broadest possible framework and the foundation for the optimum control of traffic flows. In so doing it must provide an economically efficient and rational transport system and one which minimises the burden on the environment and on people.

The effects of the increased travel needs and the rapid growth in motorization (2005 – 426 cars for 1 000 of population) cannot be relieved merely by construction of new transport infrastructure, which generally just causes more traffic, an effective transport system needs to be put in place for the management and redirection of transport flows.

A lack of investment seems the most important obstacle for implementation all kinds of policy reforms.

Decentralising infrastructure planning and implementation, in order to make better use of available resources is certainly a strategic issue.

Institutional change, decentralising government administration and finance, introducing e.g. land use planning regulations or cost recovery mechanisms, etc. will all require adjustment of existing or new legislation, which in turn can become effective only if the concerned law enforcement is properly embedded in the respective institutions.

Organisational and technical pre-conditions for future implementation and development IT technologies in transport sector are just good.

2. ASSESSMENT OF THE STATE TRANSPORT SYSTEM

In the last few years private passenger road traffic in particular has been growing at the expense of other modes of transport, which shows up in the unfavourable ratio in the choice of transport mode.

Public transport routs network is quite good, enough developed infrastructure but fleet of municipality companies is quite old and needs significant renewal.

Intercity road traffic conditions in Lithuania are at the moment are enough good. The government has to adopt the National transport development programme until 2025. From 2004 each year for transport infrastructure reconstruction and telecommunications system development in IXB, IXD and I Ten-T corridors from Cohesion fund is allocated from 200 to 250 millions euros. Road construction and technical improvements to vehicles in the last few years have been main factors behind improvement in road safety. Traffic safety in Lithuania compared with other EU countries is one of the worst (760 fatalities in 2005).

In the big town centres parking problems are very sharp. In the Vilnius centre municipality is planning to build network of multilevel parking places.

In the biggest Lithuania towns there is a need to develop the co-ordinated traffic control systems. There also exist public transport traffic problems during the rush hours.

3. DRIVING FORCES

The defining of priority goals in transport policy, which are to ensure cost-effectiveness of transport, protection of the environment and traffic safety, is based on the undesirable trends that have been identified in the transport system.

Control of traffic flows:

- Ensuring at least a minimum level of mobility;
- Reducing the of transit traffic in the city centres;
- Promoting non-motorised transport (walking, cycling);
- Redirecting passenger traffic to public transport;
- Encouraging co-operation between companies providing public transport (municipality companies and private public transport companies).

Protection of the environment:

- Rational use of the physical environment;
- Reducing air pollution from vehicle emissions (restricting for the import of second hand cars older than 10 years);
- Reducing the noise level of road and rail traffic;
- Reducing the harmful effects of air traffic on the environment;
- Preventing pollution of the sea and the environment from maritime traffic;
- Dealing with the problem of recycling old cars and car parts and tyres;
- Providing public information on protection of the environment.

Reducing the number of accidents:

- Introducing complex of measures to increase road safety;
- Retaining the existing levels of safety in rail and air traffic;
- Preserving the high level of safety in maritime transport.

Development of transport infrastructure in Soviet times was made on the basis of twice-lower traffic forecasts. For that reason the main street crossings and bridges in the centres of the biggest towns are overloaded and now it is very difficult to reconstruct them.

4. LOCAL TRANSPORT STRATEGIES

A transport policy cannot guarantee perfection or excellence in advance. Attention needs to be focused on the establishment of mechanisms for responding to changes in the external environment.

Regional and local policies at the moment do not exist. Local authorities are responsible for the implementation at the state-level-made transport decisions, local public transport service and compensation of a part of passengers' transportation expenses.

Databases, computer networks and Internet access technologies are already in use on all levels.

Data collection include data on freight and passenger transport – by road, rail, air and water, transport costs, transport volumes, accidents, fuel consumption, environmental effects, aggregated and detailed local statistics. The Ministry of Transport was established the transport data base which is under the development. Till this time we do not have unified transport data collecting system especially at border crossing points. Municipalities and public transport companies are organising their own traffic and passengers flows surveys.

Traffic management systems partially are implemented in bigger cities (Kaunas, Vilnius, Klaipeda). It includes the integrated traffic control, public transport priority in some municipal streets (where is enough space), incident and emergency management.

Traveller and driver information is available at National motorway association, road howlers association LINAVA and on radio (TV programmes).

For public transport there is an overall vehicle schedule available. Demand – responsive public transport is not yet available.

Law enforcement is still one of the main difficulties on state and local level. A lot of penalties are not enforced due to non effective enforcing system.

A lot of specific technologies are implemented in projects and in real life. Variable message signs are in use on state roads to warn the drivers of dangerous (black) spots on the roads, advanced modelling and simulation techniques are implemented to forecast the traffic flows, expected noise and air pollution, traffic jams and so on. Also the GIS systems are in use, as well as GPS systems.

5. FRAMEWORK FOR FUTURE TELEMATICS SOLUTIONS

To apply a modern IT technologies public authorities have to specify the user needs. It means that they have to reveal all different reasons for interrupted traffic flows, parking problems, traffic safety problems, and specific weather conditions in the country and so on. It is needful to create applicable unified transport information system.

So far there was no need yet for an immense telematics uptake in our transport system. Traffic flows can still tolerate a smooth course of traffic. In future, with no doubt, the modern IT systems will be needed.

The priority systems and applications are as follows:

- public transport vehicle scheduling and control;
- environmental friendly transport management;
- collective roadside information for drivers;
- parking management;
- information on traffic pollution;
- smart cards for ticketing;
- electronic signboards;
- freight traffic logistics;
- transport policy impact assessment.

6. CONCLUSIONS AND RECOMMENDATIONS FOR THE FUTURE ACTIONS

The contemporary information technologies in transport sector will be very important for the optimum control of traffic flows. Therefore it is necessary to implement the following systems and sub systems:

- emergency call-direct connection with the operator of local road basis;
- weather system – for the road maintenance;
- traffic counting and classification;
- video survey – where traffic jams occur and combined with electronic signboards;
- velocity inspection – with digital cameras;
- automatic toll collection;
- collective roadside information for drivers.

The main aim is to set the transport information and statistics system that could enable to provide all transport service suppliers and customers with operative information in the most convenient and precise way but respective services to gather and process statistical information, that could enable all transport related institutions and organisations to utilise the data in analysing, forecasting and passing decisions with regard to transport operations.

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CONSTRUCTION AND ESTIMATION OF THE NORMALIZED MODEL PARAMETERS FOR TRAFFIC FLOWS CUSTOMS OPERATION SYSTEM IN A BORDER CONTROL TRANSIT ZONE

Valery Nikolsky, Alexander Berezhnoy

Transport and Telecommunication Institute
Lomonosova 1, Riga, LV-1019, Latvia
Phone: (+371)29595329, (+371)29110030. E-mail: nv@tsi.lv, avb@tsi.lv

In the given research, the construction of the normalized mathematical model of traffic flows customs operation system with the single queue is made for a border control transit zone at any distributions of an entry transport stream as well as holding and waiting times. An evaluation of model functioning probabilistic parameters is performed and system general operational characteristics for a stationary operating mode are determined. Taking into account the obtained ratios the choice of the check gates quantity for servicing the given intensity traffic flow is made.

Keywords: queuing theory, stochastic normalization, model of a customs operation control zone

1. INTRODUCTION

In a sphere of road and transport management a special stress is put on tasks of transport network throughput dynamic control. Recently, one of the "bottlenecks" has become the road transit in customs check operations at the border control zones. The reasons of queues occurrence, as a rule, are economic forces or the legislative-administrative restrictions resulting in redistribution of freight traffics volume directed to the certain customs operation control zones. Long-term prospective of a problem solution are rooted in finding out of ways of growth for a boundary transit zones amount and productivity. However even for the existing travel demand, at known available capacity resources on border gates throughput, there still remains a problem of the most effective automobile streams servicing mode selection. Mentioned reasons cause the necessity in development of mathematical model of a border control customs check zone. While constructing classical models of similar type, the mathematical apparatus of the queuing theory is usually used. Thus often proceed from the assumption, that time between the neighbouring vehicles in arriving traffic stream has the Poisson distribution, and the servicing process has an exponential distribution [1]. Meanwhile, the processes proceeding in a border zone not always can be related to a Markovian models class. As it is shown in the present article, this circumstance can be taken into account constructing models with the assistance of stochastic systems normalization method [2].

2. SYNTHESIS OF A CUSTOMS CHECK OPERATIONS ZONE MODEL

Let's consider the operation process of boundary customs check zones. We shall assume that in each of directions to the border transit point there exists the only lane, where traffic queues accumulation takes place. The vehicle stream generated from queue is served at n check gates (Fig.1). The processing discipline is First In First Out (FIFO). In case if all of control passing gates are occupied, a vehicle remain in the queue till the moment when any of the check gates becomes available. As a result of passing the procedure of the boundary customs check, there are two possible types of service – successful pass and service refusal. There are two possible service refusals: the first one is connected with queue size limitation and the second one, connected with possible non-conformances revealed during the check procedure, for example, non-conformance of documents, absence of the vehicle power of attorney, presence of the illegal goods etc.

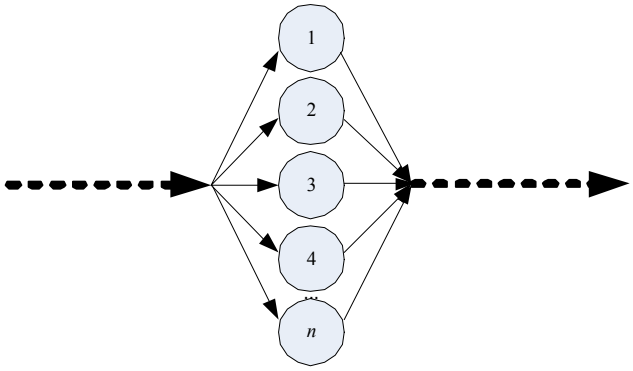

Fig. 1. *Border control customs operation system functional scheme*

Let's designate the traffic intensity at the entry vehicle stream – m_x; the intensity of servicing process for passing vehicles at the check gates – μ; the vehicles shift intensity in the queue – υ.

By means of using the stochastic systems normalization method, according to [2], it is possible to present the considered system with the model, represented on Fig. 2.

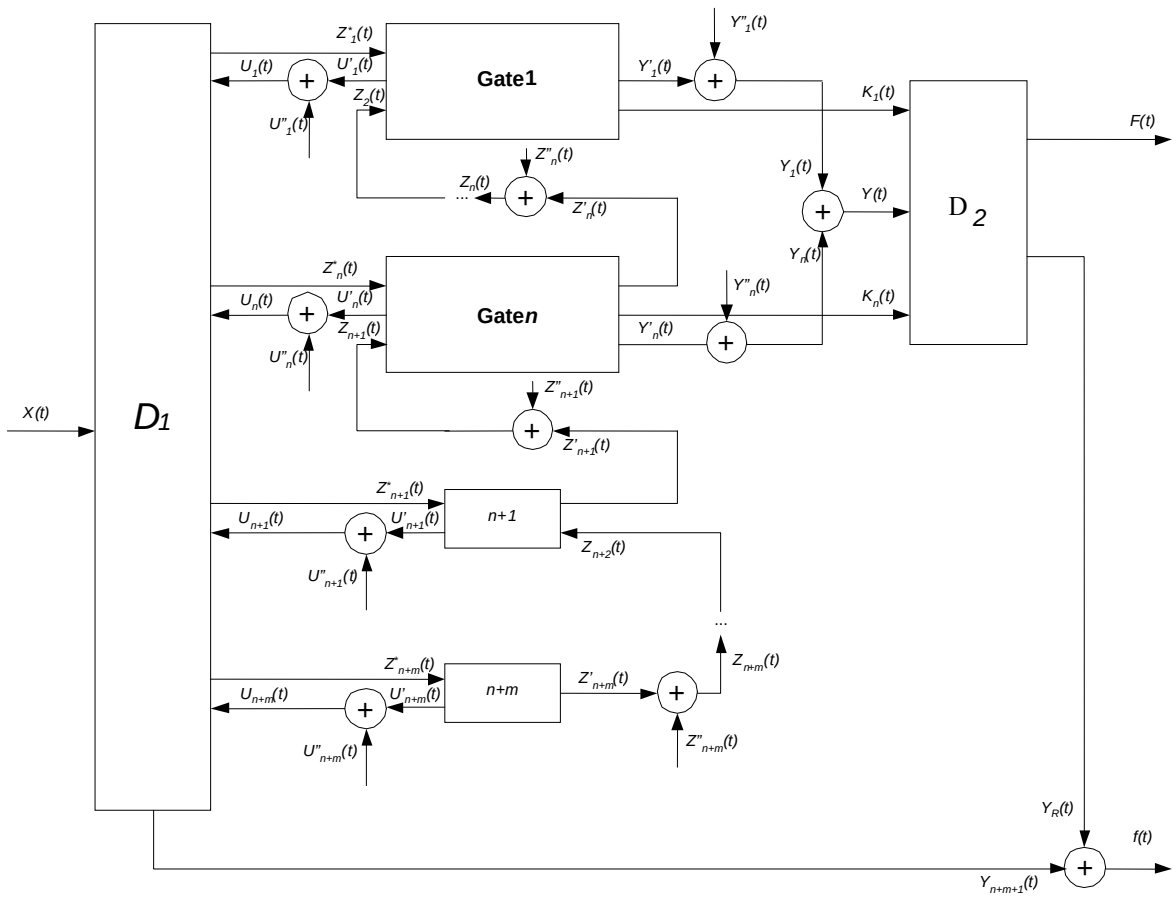

Fig. 2. *The border control customs operation system model scheme with n servers and finite queue size*

In Fig. 2 the following designations are accepted:

Gate 1 – Gate *n* – check gates where customs inspection and official registration of papers is made that will be interpreted as servers;

D_1 – the distribution block that determines a motion direction of a traffic flow depending on the condition of servers and queue cells;

D_2 – the distribution block responsible for the further vehicle stream cleavage, considering the second service refusal type;

$X(t)$ – an entry traffic flow;

$Y(t)$ – the unified output vehicle stream after the check procedure;

$Y_{n+m+1}(t)$ – a traffic flow, containing the vehicles that have not passed through due to the queue overflow;

$U_i(t)$ – signals regarding the servers and queue cells status;

$Y_i^{''}(t), U_i^{''}(t), Z_i^{''}(t)$ – additive normal noise with zero distribution averages;

$Y_i^{'}(t), U_i^{'}(t), Z_i^{'}(t)$ – internal model variables;

$K_i(t)$ – signals, regarding the second service refusal type;

$F(t)$ – traffic output stream, containing the vehicles that have successfully passed the customs check;

$f(t)$ – traffic output stream consisting of vehicles that have failed to pass customs inspection.

Set of the equations describing the dynamics of system functioning, could be written as follows:

$$Z_i^*(t) = X(t)\cdot[m_{U_{i-1}}(t) - m_{U_i}(t)] + m_x(t)\cdot[\overset{0}{U}_{i-1}(t) - \overset{0}{U}_i(t)],\ \ i = \overline{1, n+m} \tag{1}$$

$$Y_{n+m+1}(t) = X(t)\cdot m_{U_{n+m}}(t) + m_x \cdot \overset{0}{U}_{n+m}(t), \tag{2}$$

$$Z_i(t) = \begin{cases} \dfrac{i-1}{i}\displaystyle\int_{t_0}^{t}[Z_i^*(\tau) + Z_{i+1}(\tau)]\cdot\varphi_i(t-\tau)d\tau + Z_i^{''}(t), & i = \overline{1, n} \\ \displaystyle\int_{t_0}^{t}[Z_i^*(\tau) + Z_{i+1}(\tau)]\cdot\bar{\varphi}_i(t-\tau)d\tau + Z_i^{''}(t), & i = \overline{n+1, n+m} \end{cases} \tag{3}$$

$$U_i(t) = \begin{cases} \displaystyle\int_{t_0}^{t}[Z_i^*(\tau) + Z_{i+1}(\tau)]\cdot\psi_i(t-\tau)d\tau + U_i^{''}(t), & i = \overline{1, n} \\ \displaystyle\int_{t_0}^{t}[Z_i^*(\tau) + Z_{i+1}(\tau)]\cdot\bar{\psi}_i(t-\tau)d\tau + U_i^{''}(t), & i = \overline{n+1, n+m} \end{cases} \tag{4}$$

$$Y_i(t) = \frac{1}{i}\int_{t_0}^{t}[Z_i^*(\tau) + Z_{i+1}(\tau)]\cdot\varphi_i(t-\tau)d\tau + Y_i^{''}(t),\ \ i = i = \overline{1, n} \tag{5}$$

$$Y(t) = \sum_{i=1}^{n} Y_i(t), \tag{6}$$

where $\overset{0}{U}_i(t)$ – centred stochastic functions, and $m_x(t)$, $m_{U_i}(t)$ and $m_y(t)$ – distribution averages of stochastic functions $X(t)$, $U_i(t)$ and $Y(t)$;

$\varphi_i(t-\tau)$, $\psi_i(t-\tau)$, $\varphi_i^-(t-\tau)$, $\psi_i^-(t-\tau)$ – the weight functions obtained from the corresponding distribution densities of servicing and waiting times.

For the condition variables in a stationary mode it is possible to write:

$$m_{Z_i}^* = m_x(m_{U_{i-1}} - m_{U_i}), i = \overline{1, n+m} \tag{7}$$

$$m_{Y_{n+m+1}} = m_x \cdot m_{U_{n+m}} \tag{8}$$

$$m_{Z_i} = \begin{cases} \dfrac{i-1}{i}(m_{Z_i}^* + m_{Z_{i+1}}) \displaystyle\int_{-\infty}^{t} \varphi_i(t-\tau)d\tau, & i = \overline{1,n} \\ (m_{Z_i}^* + m_{Z_{i+1}}) \displaystyle\int_{-\infty}^{t} \bar{\varphi}_i(t-\tau)d\tau, & i = \overline{n+1, n+m} \end{cases} \tag{9}$$

$$m_{U_i} = \begin{cases} (m_{Z_i}^* + m_{Z_{i+1}}) \displaystyle\int_{-\infty}^{t} \psi_i(t-\tau)d\tau, & i = \overline{1,n} \\ (m_{Z_i}^* + m_{Z_{i+1}}) \displaystyle\int_{-\infty}^{t} \bar{\psi}_i(t-\tau)d\tau, & i = \overline{n+1, n+m} \end{cases} \tag{10}$$

$$m_{Y_i} = \frac{1}{i}(m_{Z_i}^* + m_{Z_{i+1}}) \int_{-\infty}^{t} \varphi_i(t-\tau)d\tau, \quad i = \overline{1,n} \tag{11}$$

$$m_Y = \sum_{i=1}^{n} m_{Y_i} \tag{12}$$

A vehicle that passes through the check procedure can get the second type service refusal with a probability P_{K_i} for each server. We assume that refusal probabilities are equal for all servicing units and it becomes possible to introduce the unified service refusal probability index of the check gates – P_R.

Consequently it is possible to obtain:

$$F(t) = (1 - P_R) \cdot Y(t), \tag{13}$$

$$Y_R(t) = P_R \cdot Y(t), \tag{14}$$

$$f(t) = Y_{n+m+1}(t) + Y_R(t). \tag{15}$$

3. MODEL ANALYSIS

Let's consider characteristics of a customs check zone in the stationary mode.

For stationary probabilities of the system conditions P_j it is possible to write down:

$$\begin{aligned} &P_0 = 1 - m_{U_1}, \\ &P_1 = m_{U_1} - m_{U_2}, ..., P_i = m_{U_i} - m_{U_{i+1}}, \\ &P_n = m_{U_n} - m_{U_{n+1}}, \\ &P_{n+1} = m_{U_{n+1}} - m_{U_{n+2}}, ..., P_{n+m} = m_{U_{n+m}}. \end{aligned} \tag{16}$$

Taking into account, that:

$$\int_{-\infty}^{t} \varphi_i(t-\tau)d\tau = 1, \ \int_{-\infty}^{t} \psi_i(t-\tau)d\tau = \frac{1}{i\mu}, \ i = \overline{1,n}$$

$$\int_{-\infty}^{t} \bar{\varphi}_i(t-\tau)d\tau = 1, \ \int_{-\infty}^{t} \bar{\psi}_i(t-\tau)d\tau = \frac{1}{n\upsilon}, \ i = \overline{n+1,n+m}, \tag{17}$$

it is possible to find:

$$P_{n+m} = \frac{\rho_1^m \rho^n P_0}{n! n^m [1 - \frac{\rho - \rho_1}{n}(1 + \frac{\rho}{n})]}, \ n \geq 2, \tag{18}$$

$$P_0 = \left\{ 1 + \rho + \sum_{i=1}^{n-1} \frac{\rho^{i+1}}{(i+1)!} + \frac{\rho^{n+1}[1 - (\frac{\rho_1}{n})^m]}{n!(1 - \frac{\rho_1}{n})[n - (\rho - \rho_1)(1 + \frac{\rho}{n})]} \right\}^{-1}, \tag{19}$$

$$P_j = \begin{cases} \dfrac{\rho^j P_0}{j}, j = \overline{1,n} \\ \dfrac{\rho^n P_0}{n![1 - \frac{\rho - \rho_1}{n}(1 + \frac{\rho}{n})}, j = \overline{n+1,n+m}, \end{cases} \tag{20}$$

where P_{n+m} – probability of a servicing refusal due to the queue overflow; $\rho = \frac{m_x}{\mu}$; $\rho_1 = \frac{m_x}{\upsilon}$, μ – vehicle stream servicing intensity at the check gates; υ – queue cells resolving rate; P_0 – probability of the case when all check gates stay unoccupied; P_j at $j = \overline{1,n}$ – probability showing that j check gates are occupied, meanwhile the number of vehicles passing through servicing does not exceed the number of check gates; P_j at $j = \overline{n+1,n+m}$ – probability of a vehicle delay in the entry queue.

The absolute meaning for throughput of a border control customs transit zone without considering the possibility of service refusal due to the reasons of documents preparation or freight transportation rules non-conformances:

$$m_y = m_x(1 - P_{n+m}). \tag{21}$$

An average intensity for the vehicles that have not passed the check gates due to the entry queue overflow:

$$m_{y_{n+m+1}} = m_x P_{n+m}. \tag{22}$$

The absolute meaning for the system throughput taking into account all the possible service refusal types:

$$m_F = m_y(1 - P_R) = m_x(1 - P_{n+m}) \cdot (1 - P_R). \tag{23}$$

The numerical value of the demanded quantity of check gates can be calculated from the expression (21) for the given values of throughput and intensity of an entry traffic flow.

The relative throughput of the system before the 2nd distribution block could be evaluated as follows:

$$q^* = 1 - P_{n+m}. \tag{24}$$

The relative throughput of the system regarding all possible service refusal types:

$$q = (1 - P_{n+m}) \cdot (1 - P_R). \tag{25}$$

Knowing the probabilities of systems conditions (16), it is possible to determine the waiting block key parameters of. So, average quantity of the vehicles waiting for the check procedure in the queue is as follows:

$$\bar{r} = 1 \cdot P_{n+1} + 2 \cdot P_{n+2} + ... + m \cdot P_{n+m},$$

$$P_{n+1} = (\frac{\rho_1}{n}) \cdot P_n, \quad P_{n+2} = (\frac{\rho_1}{n})^2 \cdot P_n, \quad P_{n+m} = (\frac{\rho_1}{n})^m \cdot P_n,$$

$$P_n = \frac{\rho^n P_0}{n![1 - (\frac{\rho}{n} - \frac{\rho_1}{n}) \cdot (1 + \frac{\rho}{n})]}. \tag{26}$$

Hence,

$$\bar{r} = \frac{\rho_1[1 - (\frac{\rho_1}{n})^m (m + 1 - \frac{m\rho}{n})]\rho^n P_0}{n \cdot n![1 - \frac{(\rho - \rho_1)(1 + \frac{\rho}{n})}{n}](1 - (\frac{\rho_1}{n}))^2}. \tag{27}$$

From (25) an average waiting time in queue could be found:

$$\bar{t_w} = \frac{\bar{r}}{\rho_1 \upsilon}. \tag{28}$$

The system's response time before the second distribution block:

$$\bar{t_s} = \bar{t_w} + \frac{q^*}{\mu}. \tag{29}$$

And the total system's response time:

$$\bar{t_s} = \bar{t_w} + \frac{q^*}{\mu} + \bar{t_p}, \tag{30}$$

where $\bar{t_p}$ is the average processing time of the second distribution block.

CONCLUSION

As a result of the carried out analysis of the constructed border control customs check zone model it is possible to obtain expressions of several characteristics – throughput, average queue length

and waiting time. Defined ratios also allowed solving the selection problem of the check gates quantity demanded for maintenance of guaranteed service of a vehicle stream of known intensity. It appears useful from the practical point of view at designing or modernization of border control customs check operation system.

The analysis of the deducted expressions for characteristics of border control customs operation system shows, that at the Poisson distribution of vehicles entry stream with the intensity $m_x = \lambda$ and $\upsilon = \mu$, characteristics of system transform to the values corresponding to the Markovian model.

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DEVELOPMENT OF INFORMATION SYSTEM FOR COACH TERMINAL

Vaira Gromule

JSC "Rīgas Starptautiskā Autoosta"
Pragas Str. 1, Riga, LV-1050 Latvia
Phone: (+371)7503646. Fax: (+371)7507009
E-mail: autoosta@autoosta.lv

This paper presents the development of the information system for the coach terminal. The operation of coach terminal is connected with a large scale operatively changing data processing. The development of modem information technologies and their availability to passengers and hauler companies allow developing and improving information systems for the coach terminal operation and provide services to passengers and hauler companies. Thereby, the development of information systems and their wide application in practice is one of the most essential factors that allow the coach terminal to form as a passenger logistics hub.

The information system of the coach terminal corresponds to the Decision Support System (DSS), thereby providing the compatibility of the organization management system with the Quality Standard ISO 9001:2000 within the operational sphere of passenger traffic servicing and provision, ticket sales and trip record keeping management.

The work describes the information system of the coach terminal: technical architecture, operating principles and user work organization.

Keywords: coach terminal, passenger logistics hub, information system, decision support system

1. BUS AND COACH TRANSPORT IMPORTANCE IN PUBLIC TRANSPORT

Bus and Coach Transport holds a 9.5% share of all ground transport service within the European Union and after passenger cars remains the most important means of transportation available to the public. In passenger/kilometre terms, the sector has met steady growth of 5% from 462 million in 1995 to 486 million in 2002. These figures include both domestic and international journeys.

Table 1. Performance by 4 Modes for Passenger Transport EU-25
(1000 million passenger/kilometres) [1]

	Passenger Cars	Bus&Coach	Railway	Tram&Metro	Total
1995	3703	462	319	51	4535
1996	3774	467	325	52	4618
1997	3844	467	327	52	4690
1998	3932	474	329	53	4788
1999	4009	476	339	55	4879
2000	4074	480	346	56	4956
2001	4118	483	348	57	5006
2002	4203	486	346	57	5092
1995 - 2002	**14%**	**5%**	**9%**	**13%**	**14%**
per year	**1,8%**	**0,7%**	**1,2%**	**1,7%**	**1,7%**

Bus and coach transport is the most used form of public transport and it shows the tendency to stabilize. The place of the bus and coach transport in public transport in Latvia (million passengers per year) is shown in Table 1.

Bus and coach terminals being the infrastructure objects of passenger transport hold great significance in passenger services.

For instance, JSC „Riga International Coach Terminal" (RICT) cooperates with 53 hauler companies and 5 travel agencies. 13 foreign countries are the destination of coaches from "Riga

International Coach Terminal" and 63 international runs were serviced per day. RICT provides services to regional (local) and long-distance routes – 565 domestic runs per day. Every day the terminal sells 8-10 thousand tickets to carrier routes.

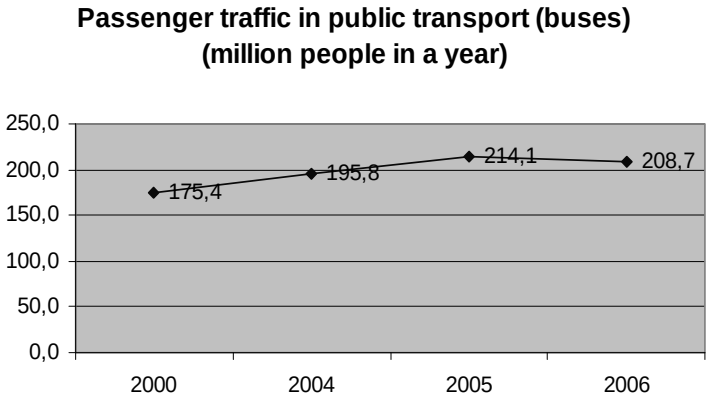

Fig. 1. *Passenger Traffic [2]*

2. OPPORTUNITIES OF LOGISTICS DEVELOPMENT

The JSC "Riga International Coach Terminal" is a member of the Pan European Association of Coach Terminals. One of the main objectives of the mentioned Association is to develop the logistics services within the area of passenger transportation for both the passengers and the haulers.

The role of the JSC "Riga International Coach Terminal" in passenger transport infrastructure today complies with the passenger logistics hub. Several essential factors must be provided for the full-value operation of the passenger logistics hub:

- Strategic location of the coach terminal;

Favourable geographic location, close to administrative, trade and culture centres with a possibility to transfer to other kinds of public transport.

- Support by the government;

The governmental institutions play a significant part in regulation of services in public transport and coach terminal operation: government orders, policy of state subsidies, tax policy.

- Logistics infrastructure services;

When running a coach terminal it is very important to have internal logistics of its operation, the level of infrastructure, the variety and quality of services rendered. The most significant preconditions are characterized by the following:

- access possibilities for bus and coach passengers,
- participants of external traffic,
- content and layout of information for passengers,
- level of comfort,
- security and protection of passengers.

- Partnership and opportunities of logistics development;

The coach terminal, while providing services to passengers, cooperates with numerous partners. First, they are hauler companies that fulfil their own marketing policy, mutually competing or/and forming unions. The coach terminal must provide services to haulers taking into account their interests, however, preserving neutrality so that passenger interests do not suffer. Besides, it is very important for the operation of the coach terminal to ensure multiple services involving external service providers.

- Quality of labour force;

The decisive factor in high service quality insurance is the human factor – professionally trained and motivated employees.

- Development of information technologies;

Along with other important factors determining a successful operation of PLM is the development of information technologies. The development of the Internet spread of e-commerce, possibilities to organize more efficiently client services, widening access to the provided services.

Passenger Logistics Hub

Strategic location	Support by government	Logistics infrastructure services	Partnership. Opportunities of logistics development	Quality of labour force	Development of information technologies
- Market share; - Location;	- Regulation of entrepreneurship; - Tax legislation; - State aid (grants, recovery of losses);	- Technical characteristics of a coach terminal; - Possibilities of inter-modal transfers; - Level of services;	- Co-operation with haulers; - Co-operation with public authorities regulating haulers; - Co-operation with other stakeholders, (Travel agencies, service providers etc.)	- Training of personnel; - Management of human resources; - Ensuring high quality services;	- IT and telecommunication infrastructure; - WEB based easy interface; - E-commerce platform;

Fig. 2. *Critical factors for logistics hub [3]*

3. INFORMATION TECHNOLOGY IS AN IMPORTANT FACTOR OF SUCCESSFUL DEVELOPMENT OF PASSENGER LOGISTICS

It is necessary to form and develop the information system of the coach terminal more efficiently in order to optimize the operation of the coach terminal, to improve the work with haulers and to make the services of the coach terminal and carrier companies more comfortable for passengers, thus providing a better access to coach and bus transport services.

The development of information technologies that includes the IT and telecommunication infrastructure, the WEB based easy interface and an e-commerce platform allows to ensure access to both the passengers and hauler companies, thus widening the range of the coach terminal operation and services.

The information system used by the coach terminal collects, processes, stores, analyzes and disseminates the information providing the following principal functions:

- coach timetable and operative information about the changes;
- information about the coach movement – arrival, departure, location at the platforms, delay;
- ticket reservation and sales system, including:
    - planning of routes, using services of several hauler companies and vehicles;
    - different ways of payment and communication;
- observation of passenger rights in accordance with normative documentation;
- management and control system of the coach terminal's service processes;
- processing of operational information in economic activity accounts;
- and control.

In order to ensure these functions, the coach terminal must process a large amount of operatively changing data coming from multiple sources of information, both internal and external.

The data processed in the system is exported both for the internal use at the enterprise and to external users. The information flow is depicted in Fig.3.

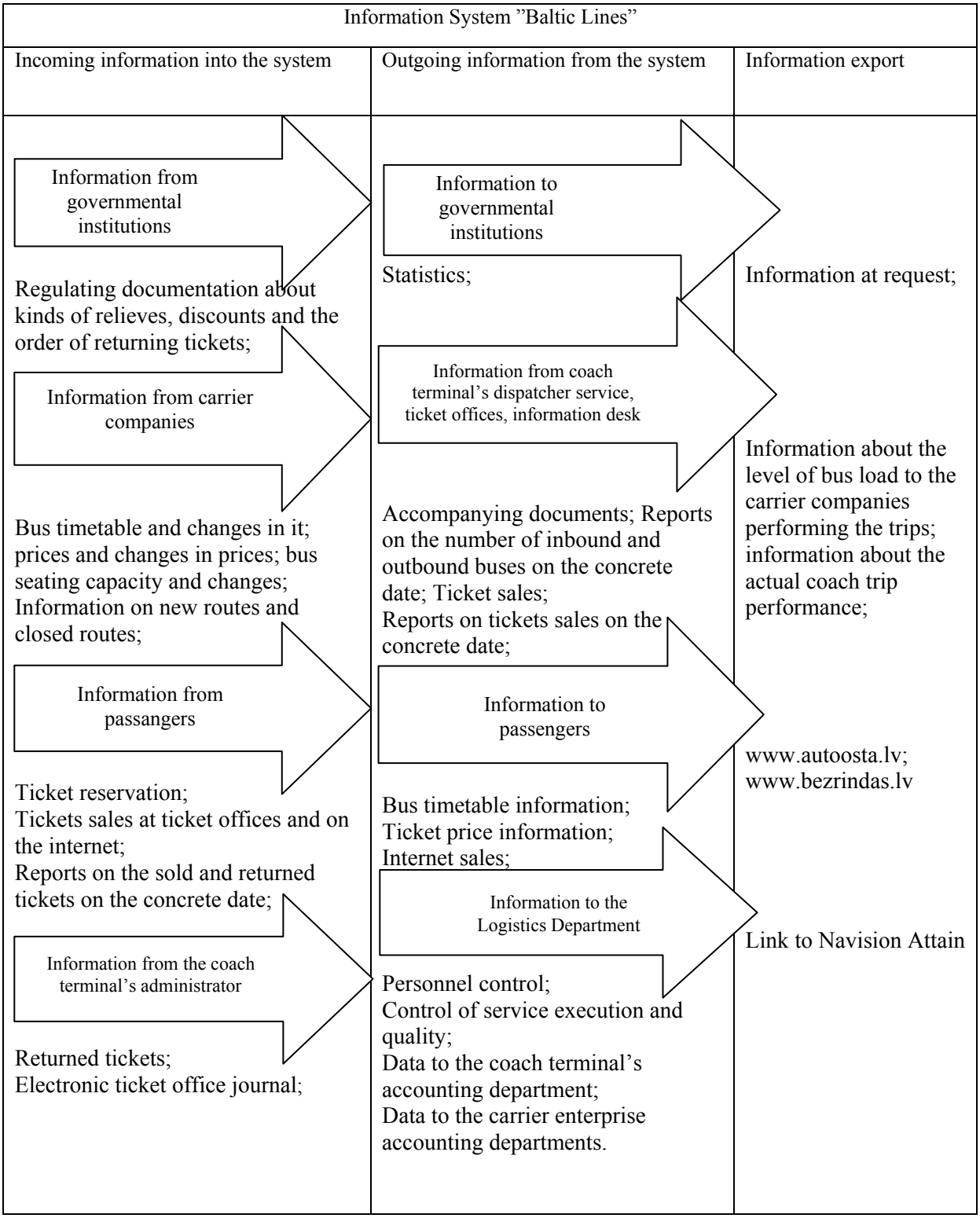

Fig. 3. *The coach terminal's information system's information flow*

4. TECHNICAL ARCHITECTURE OF THE INFORMATION SYSTEM „BALTIC LINES”

The coach terminal’s information system „Baltic Lines” comprises a three-level architecture using 72EE solution.

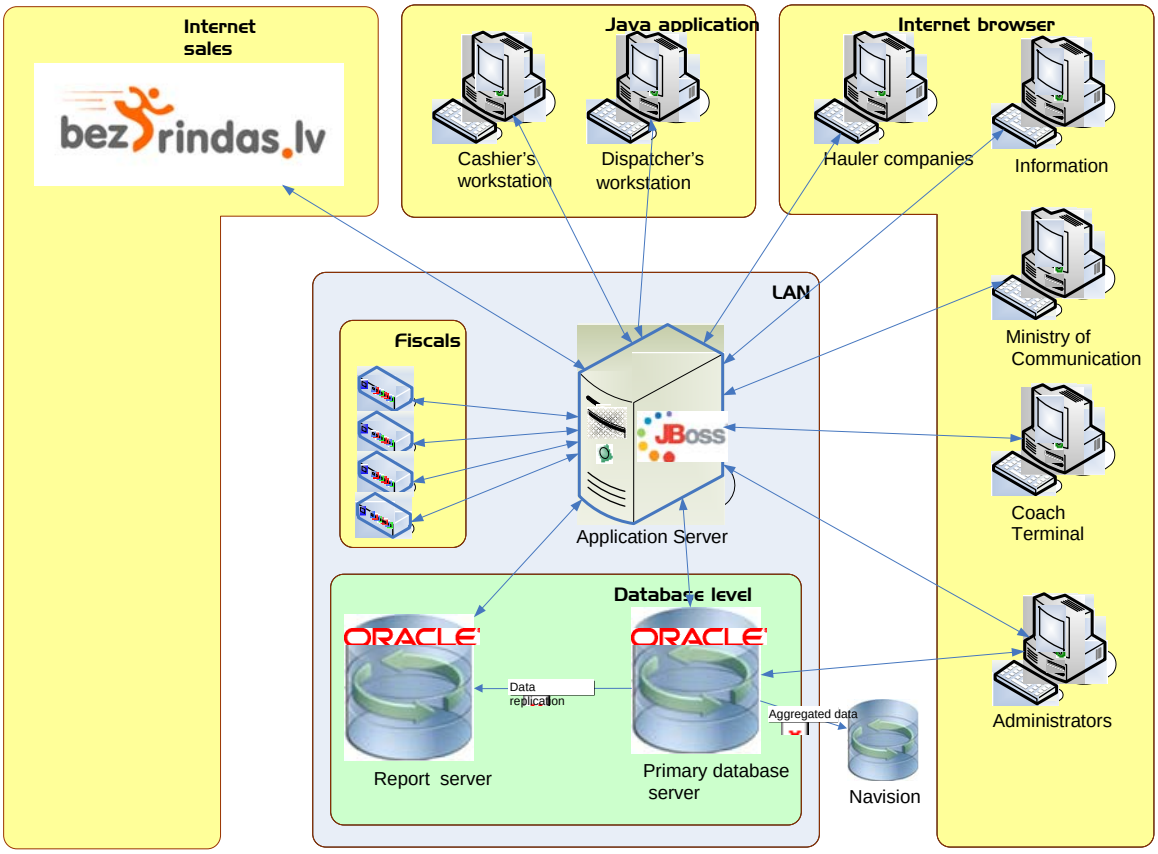

Fig. 4. *The architecture of information system „Baltic Lines”*

The characteristic indices of the information system „Baltic Lines”:

- *Database level*

Primary database server uses Oracle SE 9.2 RDBMS, planned to change to Oracle 10g version [4]. Database works on Intel platform server with Red Hat Linux Enterprise OS [5].
In order to reduce the primary database workload there is used Reporter server – an alternative server on which a regular data base replication is carried out, and which is basically used for reports, as well as for handling DEMO database operations. Database is regularly saved to reserve copies using „Hot Backup”.

- *Application server*

JBoss 3.0 Java Application server [6] ensures business logics to all activities.

- *Fiscals*

The fiscal block is connected to the application server. The fiscal block receives and stores information about all the performed finance operations. The fiscal block consists of 4 PCs, each containing 4 fiscal modules with PC ISA cards, FCS software, JBoss AS 3.0, Win 98. The PCs used in the fiscal block must have PC ISA slot.
Every module is registered for one legal entity at the State Revenue Service regional institution according the State Revenue Service regulations.

- *Workstations*

Depending on the user’s functions there are two solutions:

- Cashiers and dispatchers work with Java Browser.
- Others use Internet Browsers (Ms Internet Explorer, Mozilla Firefox, Opera).

❑ *Data flow*

Database server, Application server and Fiscal block work in the local network with 1 Gbit/s. The database with Application server use JDBC database connection protocol. Workstations work remotely using the Internet network, VPN (virtual private network) connection is provided to ensure security of data transfer to workstations. Data transfer to Navision is provided – financial information is sent daily to carrier enterprises after trips.

❑ *Internet sales* (www.bezrindas.lv)

The system of electronic ticket sales is produced by the enterprise „Mikromaksājumi" SIA in co-operation with the S Factory SIA [7]. The website is made using PHP 4.4.4 programming language and integrating the E-ticket System user's interface.
The enterprise provides the system's maintenance, administration, data reserve copy storage up to 10 GB, a 24-hour data protection against unauthorized access. The system has a guaranteed 99.5 % level of availability on workdays from 09:00 to 18:00 and total availability at 99% a month.
The guaranteed data transmission speed is the following:

- in Latvia up to 100 Mbit/s;
- there and back from other countries, up to 2048 Kbit/s.

❑ *Other possibilities*

The user right control is based on authorization mechanisms according to IP addresses, IDs and passwords. The access rights are maintained on the application server level.
Every user's configuration parameters are stored in database; therefore it is possible to administrate the users centrally.

5. ORGANIZATION OF THE INFORMATION SYSTEM „BALTIC LINES" OPERATION AT THE COACH TERMINAL

The implementation of the coach terminal's information system „Baltic Lines" made it possible to form an integrated ticket sales/reservation accounting system which ensures a new level of passenger and carrier service quality. In 2004 the coach terminal received the Quality Standard ISO 9001:2000 certificate within the operational sphere of passenger traffic servicing and provision, ticket sales and trip record keeping management.

The organization of the information system „Baltic Lines" operation at the coach terminal has been worked out. Every activity has been described and regulated according to the relevant instructions ensuring the provided services timeliness quality and uniformity.

When operating the ticket sales and coach route accounting system „Baltic Lines" the functions are divided in the following way:

- the logistics specialist registers and describes the coach's route in the system after having received the information from the state LLC „Road Transport Administration";
- the dispatcher:
  - receives phone calls from the carrier enterprises about the changes in the coach routes and enters the changes in the system's database, if any changes occur after the start of the ticket pre-sales;
  - registers the coach's arrival and departure time in the „Baltic Lines" system's database;
  - after the termination of ticket sales, prints the accompanying document from the system and hands it to the carrier enterprise driver;
- the cashier performs selling and returning of tickets;
- the information operator, using the „Baltic Lines" system's database, informs passengers about bus timetables and performs ticket reservation;
- the terminal administrator deals with non-standard situations (cancels routes, assigns the status „delayed" in case the trip is delayed), draws up a report on the ticket return if a passenger is late for the trip.

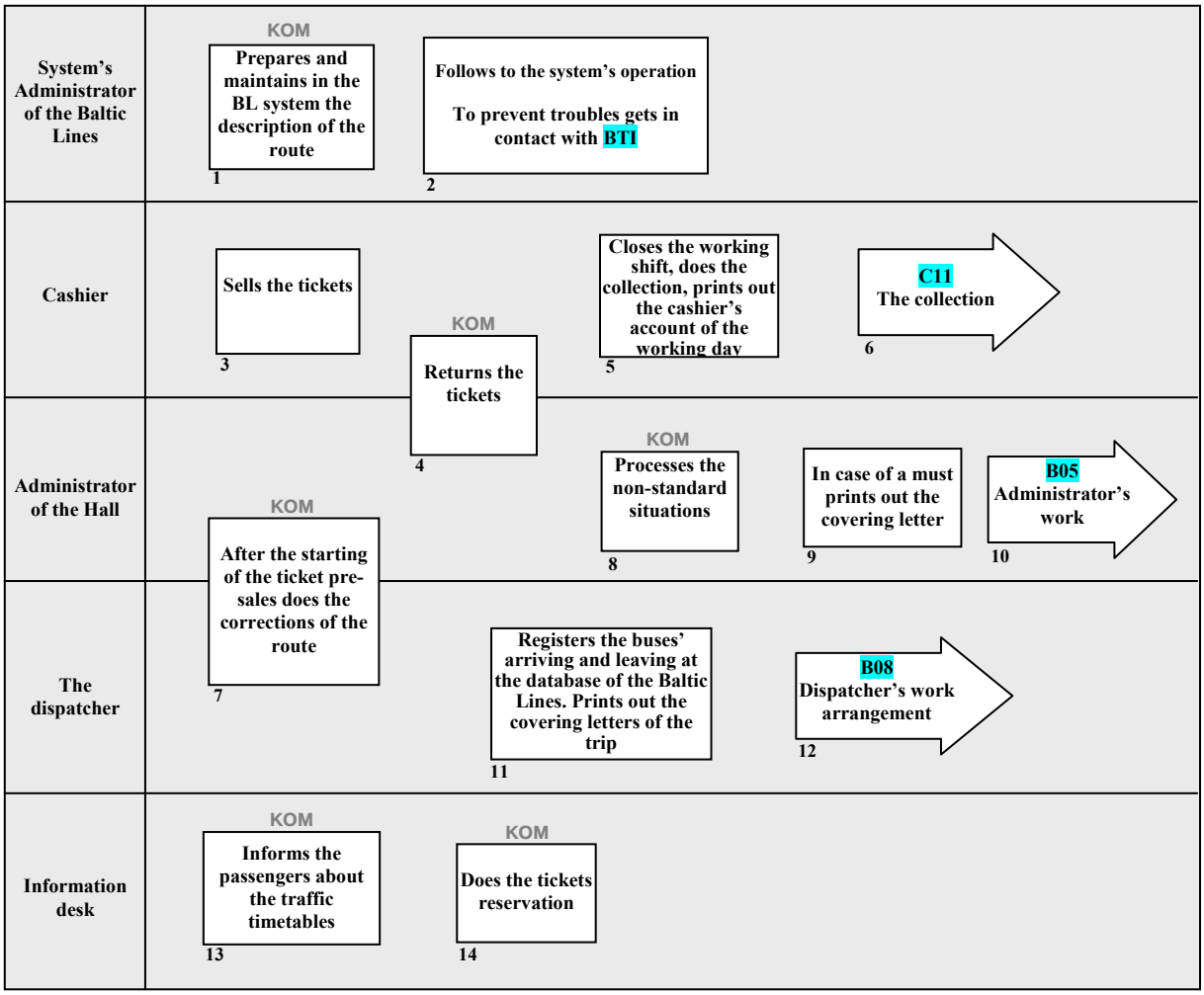

Fig. 5. *The organization of the coach terminal's information system's „Baltic Lines" operation*

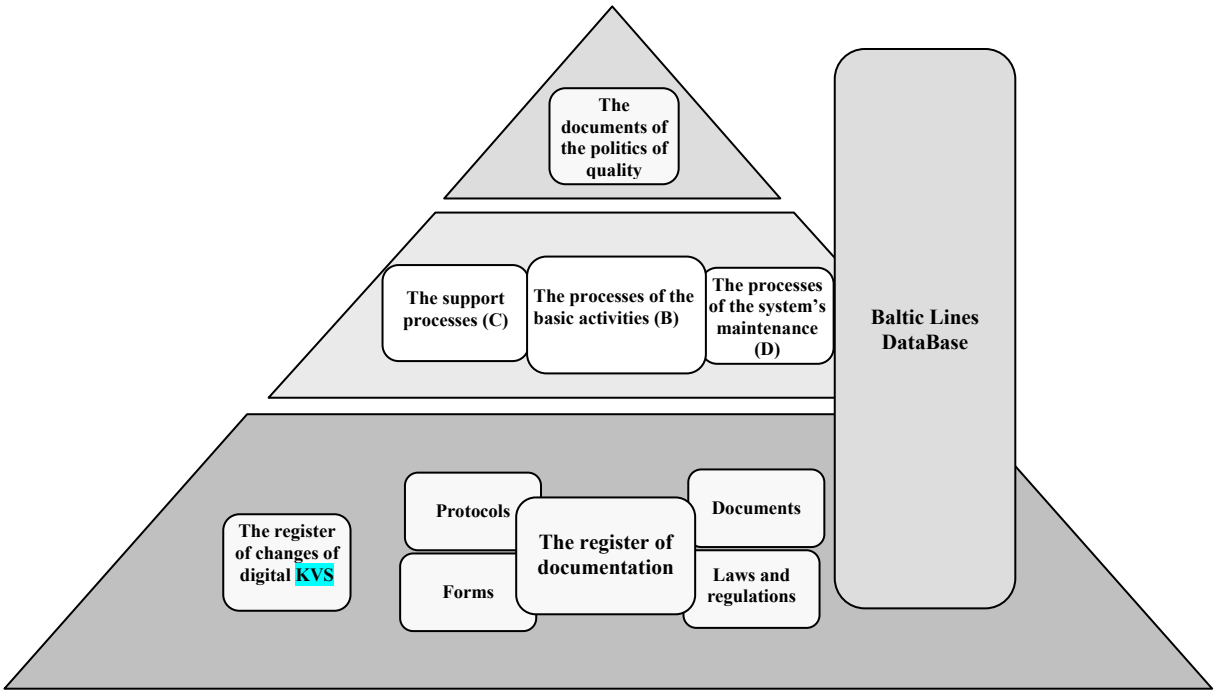

Fig. 6. *The place of the information system "Baltic Lines" in the coach terminal's quality management system*

The implementation and launching of the information system „Baltic Lines" is the basis of the coach terminal's organization management system complying with the Quality Standard ISO 9001:2000 within the operational sphere of passenger traffic servicing and provision, ticket sales and trip record keeping management.

6. THE INFORMATION SYSTEM „BALTIC LINES" AS A DECISION SUPPORT SYSTEM

Little (1970) defines the decision support system (DSS) as a "model-based set of procedures for processing data and judgments to assist a manager in his decision-making" [1]. The main DSS possibilities are to obtain the different possible solutions from quantifiable information; different possible scenarios as the consequences of possible decisions ("what if").

A DSS application can be composed of the following three major components:

- data management subsystem;
- model management system;
- user interface subsystem;
- and one optional component – the knowledge-based management module.

The coach terminal's information System is created to fulfil all the principal functions described in the work. The principal peculiarity of the information system lies in its diversity both from the points of information character and business interests.

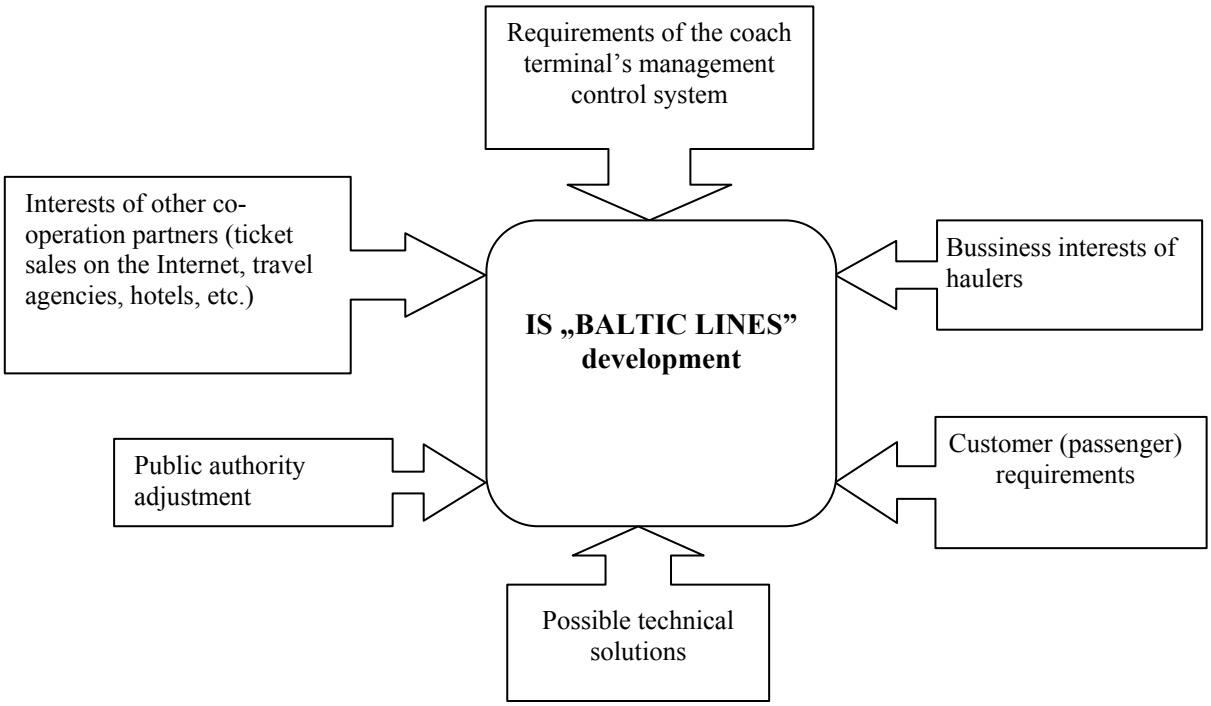

***Fig. 7**. The interests of the users influencing the development of the coach terminal's information system*

Although the information system's principal function is to provide the coach terminal's daily operation of carrier and passenger service, it includes the functions of tactical planning and control, as well as the strategic planning. The development of the system is determined by the requirements of the users and changes in the business environment.

- *Strategic planning*

The State LLC „Road Transport Administration" with the help of the „Baltic Lines" system performs the control of passenger transport implementation. The character and amount of information is sufficient to be used in making strategic decisions – on the further route network development and forming of the state order in passenger transport. The coach terminal's management, certainly, plans

the terminal's future long-term economic activity by adopting strategic resolutions on the further market, the existing and new service development building them on the coach terminal's information system's data. The determination of organizational objectives is also within the scope of strategic planning.

- *Tactical planning and control*

Tactical planning and control using the information system „Baltic Lines" is performed by the coach terminal's medium level management, as well as by the corresponding management of carrier enterprises and the state LLC „Road Transport Administration". Tactical planning and control involves the multiple activities: observing and analysis of passenger transport and bus service process; focusing on the opening of new routes and additional routes or reduction of routes, or changing the load of buses, other changes in passenger services that are of a seasonal character.

- *Operative planning and control*

The ticket sales system provides all operations necessary for passenger services: ticket reservation, selling, information, etc., ensuring passengers their rights and guarantees. The dispatcher service activities have been fully automated. Information for operational planning and control is generated almost exclusively within the organization (including requests from passengers), it is highly detailed and immediately relevant. The operation of the information system ensures the efficiency growth of the coach terminal.

CONCLUSIONS

The development of the information system is an essential factor for coach terminals, as passenger transport infrastructure objects, in their transformation into passenger logistics centres.

The development of the information system influences both the functions necessary for a coach terminal operator and the interests of different users.

The information system of the coach terminal corresponds to the Decision Support System (DSS), thereby providing the compatibility of the organization management system with the Quality Standard ISO 9001:2000 within the operational sphere of passenger traffic servicing and provision, ticket sales and trip record keeping management.

The coach terminal's information system's technical architecture and the user work organization allow enhancing continuously the system's operation in providing the coach terminal's functionality.

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THE ACCESSIBILITY FOR DISABLED PEOPLE AS A FACTOR OF DEVELOPMENT OF PUBLIC TRANSPORT SYSTEM IN LITHUANIA

Daiva Griskeviciene, Algirdas Griskevicius

Vilnius Gediminas Technical University, Transport Management Department
Plytines 27, Vilnius, LT-10105, Lithuania
Phone: (+370)52745099. Fax: (+370)52699714. E-mail: daiva1@centras.lt

The changes in attitude towards the social integration of the disabled persons have become evident on both a global and a European level. The aim of the Community action programme for accessible transport is to increase the usability of transport for persons with reduced mobility. Accessibility to public transport system and within transport means is based on European technical standards and the strategic documents of common policy. After integration of Lithuania into EU, the social integration policy has included the special means of equal possibilities for people with disabilities.

Analysis of situation of the disabled people in Lithuania shows that the main weakness is not adapted infrastructure and communication system. Absence of the integrated and well-organized public passenger transport system is a key problem for people in the cities and rural territories. Lithuanian legal basis is created for regulation of physical environment adaptation for the needs of persons with disability. However the lack of special means of public transport, adaptation of work environment, public spaces, services objects infrastructure restricts the possibilities for them to participate in the community life and increases the social separation.

Keywords: public transport service, disabled people, social integration, special passenger needs, accessibility of transport system, transport infrastructure

1. INTRODUCTION

The changes in attitude towards the social integration of people with disability have become evident on both a global and a European level. The European year of people with disabilities has been taken as an opportunity to focus attention and efforts on the subject of the social protection of persons with disabilities. That was a move away from a medical understanding towards a social understanding of disability.

The long-term aim of the Commission and of associations of transport authorities and operators is to ensure that public transport is accessible for everybody. The Community action programme for accessible transport involves a series of measures to be taken in relation to technical standards applicable to means of transport and transport infrastructure, facilitating co-operation on information programmes, and co-ordinating research programmes. Other measures envisaged include effective signs and information for travellers, co-operation between the member states regarding the harmonization of audible signals at pedestrian crossings, and compulsory training courses on disability awareness and needs.

After integration of Lithuania into EU, the social integration policy has included the special means of equal possibilities for people with disabilities. Analysis of situation of the disabled persons in Lithuania shows that the main weakness is not adapted infrastructure and communication system. Absence of the integrated and well-organized public passenger transport system is a key problem for people in the cities and rural territories.

The result of questionnaire interview of transport companies shows the different economical interests of public transport operators. Adaptation of transport means to the needs of passengers with reduced mobility is related with increased investments. Modernization of the bus or coach fleet is very sensitive economic task and may be implemented during long period. Transport infrastructure has to be modernized including special means for the disabled persons. Roads and streets development and reconstruction projects are to be prepared with the special elements for the disabled people. As well as the traffic management and control system has some primary effects.

Questioning of disable persons has emphasized the increasing needs for transport and communications, as well as for wider implementation of IT technologies.

Lithuanian legal basis is created for regulation of physical environment adaptation for the needs of persons with disability. However the lack of special means of public transport, adaptation of the

work place environment, public spaces, services objects infrastructure restricts the possibilities for them to participate in the community life and increases the social separation.

2. BACKGROUND OF PROBLEM DECISION IN EUROPEAN UNION

On 20 December 1993 the United Nations General assembly unanimously adopted the Standard rules on the equalization of opportunities for persons with disabilities. In accordance with Rule 15 of these Standard rules, the member states of the United Nations are under the obligation to eliminate any discriminatory provisions and create the legal bases for measures to achieve the equality of persons with disabilities.

The new version of the International classification of functioning, disability and health (ICF) of the World health organization refers to the "Standard rules on the equalization of opportunities for persons with disabilities" of the United Nations. Besides the components of body functions and structures as well as activities and participation, the ICF also includes environmental and person-related factors. In this context environmental factors can either facilitate or impede integration, and the very fact that this component is expressly included shows that a change in attitude has taken place which constitutes a move towards a social understanding of disability [1].

With respect to equality of a person with disability reference is often made to the Treaty of Amsterdam, where the Article 13 includes the prohibition of discrimination based on disability. Resolution of the Council and of the representatives of the governments of the member states meeting within the Council of 20 December 1996 on equality of opportunity for people with disabilities. Likewise with reference to the aforementioned Standard rules of the United Nations, the European Community adopted the Resolution on equality of opportunity for people with disabilities, which includes, besides the 12-point justification for the Resolution, the following requests:

- to avoid or eliminate any form of negative discrimination on the sole grounds of disability;
- to develop necessary policies on the equalization of opportunities;
- to take account of the orientations set out in the corresponding national policies for the participation of persons with disabilities in society (request to the member states);
- to take account of the principles to create equal opportunities for persons with disabilities in any relevant proposal on Community legislation, programmes or initiatives (invitation to the Commission);
- to promote the exchange of useful information and experience especially concerning innovative policies and good practice (invitation to the Commission);
- to contribute for the realization of the principles set out in the Resolution in the framework of their policies and activities (invitation to other Community institutions and organs).

On the basis of the requests formulated by the Resolution of 20 December 1996 on equality of opportunity for people with disabilities (see above) the European Union disability strategy is developed: Equality of opportunity for people with disabilities – a new Community disability strategy 1996. This strategy focuses on the strengthening the co-operation between and with the member states and increasing the participation of people with disabilities.

The high level group of member states representatives on disability has the special task of implementing the objectives set out in the Resolution of 20 December 1996 and comparing the different approaches of practical implementation in the development of socio-political strategies, disability organizations have been included to a larger extent. There is established the umbrella organization for disability organizations in Europe – the European disability forum. The aim here is the full participation of persons with disabilities in all aspects of life.

3. SITUATION OF THE DISABLED PEOPLE IN LITHUANIA

Every year our society supplements with the disabled persons and people with movement limitation. The states of nation health and comparatively growing number of elderly people in our society have influence on that. According to the data of the Department of Statistics of the Government of the Republic of Lithuania, the total number of the inhabitants of the Republic of Lithuania in 2006 was 3.39 million inhabitants.

At the beginning of 2006, 2268.8 thousand persons (66.7% of Lithuania's population) lived in 103 cities and towns, 1134.5 thousand persons (33.3% of Lithuania's population) – in almost 22 thousand rural inhabited localities. Over 2000–2005, comparable weight of urban and rural population remained almost unchanged.

With the decrease in the number of population, population structure by age has been changing as well. Due to low fertility, the number of children (aged 0-14) has been decreasing. The number of elderly people (aged 60 and older) has been increasing. Currently, each sixth man and each fourth woman are aged 60 and older (table 1). In 2005, the number of live births was 30.5 thousand, which is by 122 more than in 2004. However, in the period 2000-2005, the number of live births per 1000 population decreased from 9.8 to 8.9. The total fertility rate in 2005 made up 1.27 (in 2000 – 1.39). Such a low fertility rate does not ensure alternation of generations.

Every year more and more new inhabitants are recognized as the disabled persons. Therefore the number of disabled persons is unsteady. According to the data of the Disability and working capability evaluation office, 20.4 thousand of capable for working inhabitants were first time recognized as disabled persons in 2006 (22.3 thousand in 2005). In comparison with the data of 2005, the number of disabled persons decreased in 8%, 10 of 1000 capable for working people were first time recognized as disabled persons [2].

Table 1. Lithuanian population of major groups

Year	Population, thous.	of which			Percentage of total population		
		0–15 years	working-age	retirement age [1]	0–15 years	working-age	retirement age
2000	3512,1	765,3	2018,0	728,8	21,8	57,4	20,8
2001	3487,0	742,8	2019,4	724,8	21,3	57,9	20,8
2002	3475,6	717,1	2046,8	711,7	20,6	58,9	20,5
2003	3462,5	688,8	2076,0	697,7	19,9	60,0	20,1
2004	3445,9	662,2	2097,3	686,4	19,2	60,9	19,9
2005	3425,3	637,4	2112,3	675,6	18,6	61,7	19,7
2006	3403,3	613,7	2121,5	668,1	18,0	62,4	19,6

In comparison with the data of 2004, the number of disabled persons increased 5% in 2005 – 10 disabled persons for each thousand capable for working inhabitants (47% women and 53% men).

Often main reasons for recognition of disability are diseases of: musculoskeletal system and connective tissue – 20%; malignant tumours – 12%; nervous system and sense-organs – 11%.

2 thousand children (2.7 of each thousand children (aged 0-18)) were first time recognized as disabled people in 2006. Each third child had mental and behaviour derangement, each sixth – inborn anomalies, each seventh – illnesses of nervous system and sense-organs.

248.26 thousand of people drew a work incapacity (disability) pension and payouts related to disability in 2006. In this year about 2 thousand persons had no right to draw a work incapacity (disability) pension. Obviously about 7% persons, who are recognized as disabled persons, live in Lithuania.

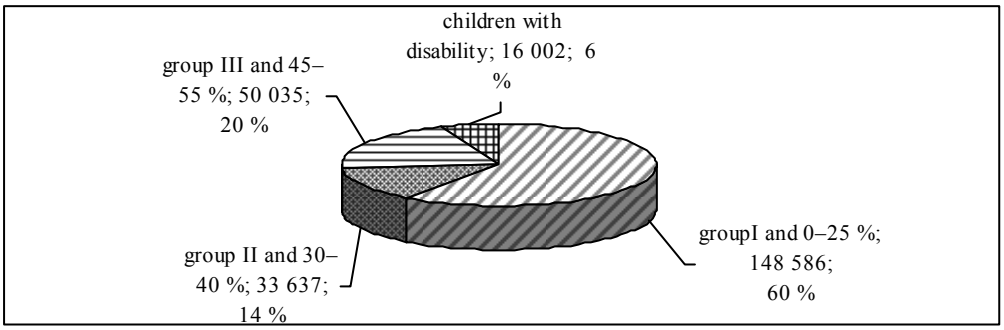

Figure 1. *Distribution of the disabled by disability, capacity level and disability level 2005*

The number of the disabled persons in our country is in line with the data of the United Nations organization that in the world people with disabilities make about 10% of the entire population. The largest part of the disabled are people with 30-40% of capacity level, or Disability group II – 148,586; these persons account for as many as 60% of the total number of the disabled (Fig. 1). The gravest disabilities have people whose capacity level is set at 0 to 25%, of Disability group I, and they make 14% of the total number of the disabled persons. In 2005, the number of the disabled persons with 45-55% of capacity level, or Disability group III, was 50,035, or 20% of the total number of the disabled persons; there were 16,002, or 6% of disabled children under 18 [2].

The society ageing process influences the increase in the number of the disabled persons – with the increase in the number of elderly people, their relative share in the total number of the disabled persons is also increasing. About 36% of the disabled persons are the persons of retirement age. Persons of working age who has certain level of capacity or disability group set make about 58%, disabled children – about 6% of the total number of the disabled persons.

Most often children are deemed disabled for the reason of diseases of the nervous system and sensation organs. Elderly people are deemed disabled most often because of diseases of the circulation system (in 2004 – 29%) and musculoskeletal system (19%) and malicious tumours (13%).

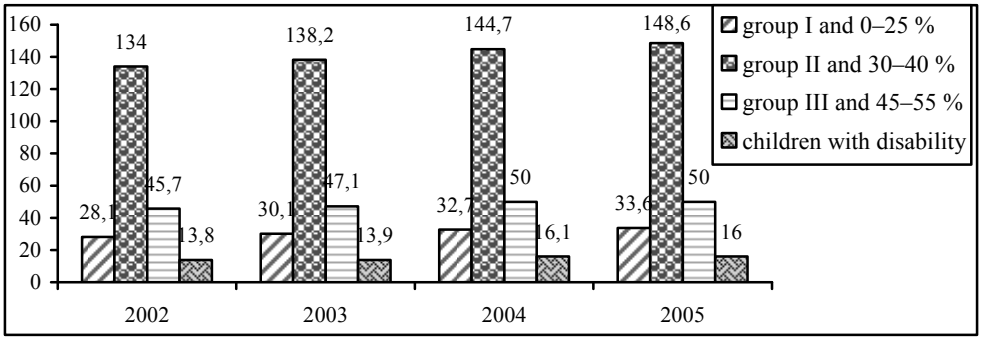

***Figure 2**. Dynamics of the number of the disabled by capacity level, disability level and disability groups in 2002-2005 (thou)*

The number of the disabled persons is increasing slightly (Fig. 2). Comparing growth in the number of disabled children in 2005 and in 2004, one can notice that in 2005 the number of disabled children decreased by 0.7%. The number of persons whose capacity level is set at 45 to 55%, or Disability group III, did not grow in 2005 either. The number of persons', whose capacity level is set at 0 to 25%, or Disability group I, grew by 2.9%. Observing the increase in the number of the disabled persons, one can state that in 2005 the number of the disabled persons grew the least since 2002, i.e. only by 1.9% as compared to 2004 while in 2004 as compared to 2003 this growth was 6.2%.

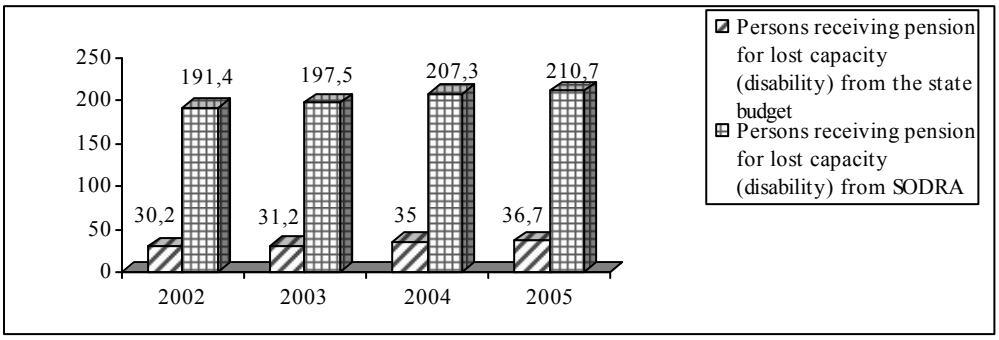

***Figure 3**. Dynamics of the number of pensioners receiving SODRA pensions and benefits for lost capacity (disability) in 2002-2005 (thou)*

Disabled persons whose capacity level, disability level or disability is set become entitled to receive pension for lost capacity (disability) which is paid to socially insured persons from the State

social insurance fund (hereinafter referred to as SODRA) and to socially uninsured persons – from the state budget (benefits and social pensions). Changes in the number of persons receiving benefits for lost capacity (disability) are not significant and as compared with 2002 the number of such persons increased by 6,515 and now makes 36,738 (Fig. 3).

However this cannot be said about persons receiving SODRA pensions for lost capacity (disability). This number is slightly increasing every year and as compared with the data of 2002, in 2005 the number of such persons was 19,308 bigger, i.e. 210 662. The increase in the number of people of this category is conditioned by high unemployment rate, high requirements on the labour market and prolonged retirement age. If to compare data of 2005 and 2004, the number of recipients of SODRA pensions for lost capacity (disability) grew just slightly, i.e. by just 1.9% and made 210,662.

4. SOCIAL INTEGRATION OF THE DISABLED PEOPLE

Key provisions of the law. A new law of the Republic of Lithuania on social integration of the disabled persons became effective from 1 July 2005. The main goal of this Law is to ensure equal rights and opportunities for the disabled persons in the society, to define principles of social integration of the disabled persons, to determine the system of social integration, the preconditions and terms, as well as the institutions in charge of the implementation of social integration of the disabled persons, the assessment of disability and working capacity level, the provision of services in vocational rehabilitation, and the principles for the identification and meeting of special needs of the disabled persons.

With the view to ensuring better satisfaction of special needs of the disabled persons, the new Law systematizes meeting of special needs by providing special assistance aids to the disabled persons. Special assistance aids are the means to meet the special needs of individuals with disabilities aimed to ensure equal possibilities for to the disabled persons to seek education, occupation, social and full-fledged integration into the society.

Special needs shall be met by providing special assistance measures: technical aids and appliances, financial support and social services in the main sphere of activities of the disabled persons (in everyday and private life, training and education, working activities and public life).

Assessing the level of special needs. The level of special needs is assessed for the persons of retirement age (hereinafter referred to as persons) and their special needs are met. Municipalities are assigned to establish the level of special needs of the disabled persons (Table 2).

Table 2. Recipients of Social services at home

	Total		Urban		Rural	
	2005	2006	2005	2006	2005	2006
Recipients of social services and warship at home	7847	7927	5024	5245	2823	2682
elderly and old (pensioner age)	3510	3730	1956	2133	1554	1597
disabled pensioner age	3427	3407	2488	2550	939	857
disabled able-bodied age	708	676	474	499	234	177
disabled children	103	102	50	53	53	49
other temporary recipients (lost their independence of illness or other reasons, etc)	99	12	56	10	43	2
Recipients of support money	719	793	115	61	604	732
elderly and old (pensioner age)	574	529	85	37	489	492
disabled pensioner age	42	55	7	7	35	48
disabled able-bodied age	103	209	23	17	80	192
Persons received the social training of skills at home	1776	4258	388	2260	1388	1998
Children of social problematic families	1149	2621	248	1332	901	1289
Persons and members of their families of risk						
groups' (alcoholic, addict, etc.)	627	1637	140	928	487	709

The level of special needs for these persons is set based on information provided by other services within their competence (e.g. physicians – based on approved disease or condition criteria, it can be established whether there is a special need for constant care or constant supervision (assistance), or the need for purchase of a specialized passenger car and compensation for technical adjustment thereof or compensation of transport expenses) and the special needs identified, interview with the person and scope of the necessary specialized aid means to meet the special needs [3,4].

Based on the approved disease or condition criteria, only a special need for constant care or only the special need for constant supervision (assistance) may be identified for one person. The special need for compensation of transport expenses and/or the special need for purchase of a passenger car and compensation of expenses on technical adjustment thereof may also be established. With regard to every such need, a separate certificate of the set form is issued to the person by the consultative commission of physicians of the health care institution where the person is registered.

The Social assistance division of the Municipality having assessed the person's special needs makes a decision with regard to assessment and meeting of the person's special needs. This person upon establishing a high, average or low level of special needs is issued the certificate of a disabled person entitling them to have privileges provided for in the legal acts. In 2005, the level of special needs was assessed for 788 persons, including 585 had a high level of special needs, and 203 – average level of special needs (Table 3).

Table 3. Recipients of other social service (thou)

Sort of service	Total		Urban		Rural	
	2005	2006	2005	2006	2005	2006
Free feeding (or supply of foodstuffs)	35,2	23,3	25,1	15,9	10,1	7,4
Supply of necessity, clothes and foot-wear	30,5	27,0	11,6	11,5	18,9	15,5
Personal hygiene service (bath)	24,0	26,8	21,4	20,8	2,6	6,0
Transport service organization	25,5	27,6	13,8	14,9	11,7	12,7
Translation into Gesture language	4,4	2,1	4,3	1,9	0,1	0,2
Maintenance by technical means for assistance	22,9	22,4	15,5	13,2	7,4	9,2
Adaptation of apartment and environment	0,23	0,34	0,16	0,22	0,07	0,12

Strategy for social integration. Aiming at meeting the needs of the disabled persons to acquire technical aids and appliances in a more efficient and rational way, the Ministry of social security and labour worked out the strategy (logistics) for providing technical aids and appliances to the disabled persons in the period of 2004-2010. The goal of the strategy is to build up a solid legal, economic and organizational system based on rational use of the State budget funds and aimed at improving the provision of technical aids and appliances to individuals with movement disorders, visual and auditory impairments, and facilitating medical, social and vocational rehabilitation [5].

Principal guidelines for the implementation of the strategy:

- to improve legal system aimed at meeting the needs of the disabled persons in acquisition of technical aids and appliances in the most efficient way;
- to assess and improve the quality of services provided to the disabled persons in separate counties, establishing local subdivisions within the country;
- to spend the state budget funds in a more rational way.

Following the implementation of the strategy, two regional technical assistance centres for the disabled persons in Vilnius and Kaunas started their activities in 2005. All in 2005, 4 regional centres were functioning: in Šiauliai, Klaipėda, Vilnius and Kaunas Counties. In 2005, as in every previous year, the procedure for public procurement of technical aids and appliances was followed and carried out. In 2005 technical aids and appliances were provided to more than 22 thousand of people. The need for compensational technical aids is met by about 90%.

Implementation of measures. In 2005, the following programmes of social integration of the disabled persons according to 7 priority components of the programme were funded: rehabilitation (vocational, psychological and social, development of skills for independent living), social services, accessibility of the environment (adjusting the public physical environment, housing and living environment and information environment), training, employment (finding a job and other forms of employment), public education, culture, sports and recreation.

In 2005 the biggest attention was given to the issues of provision of social services, accessibility of the environment, employment and rehabilitation of the disabled persons (Fig. 4). Programmes under 7 priority components were implemented by 30 organizations of the disabled persons, 7 health care, vocational rehabilitation, vocational training and educational institutions, the Lithuanian choir of the blind Vilnius and the Council proper.

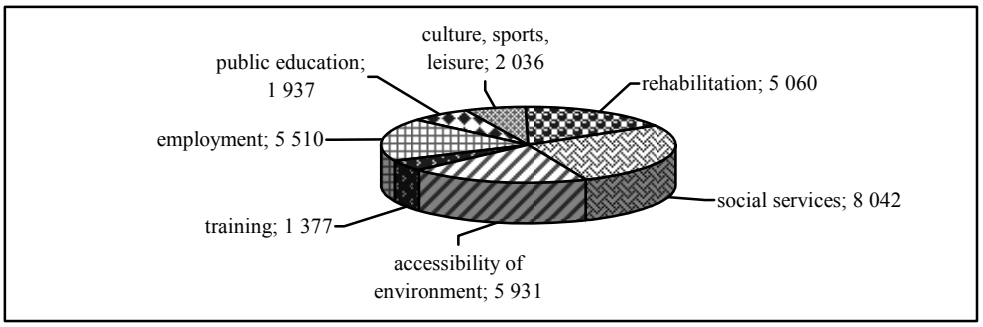

***Figure 4**. Use of funds allocated for the Programme of social integration of the disabled persons in 2005 (LTL thou)*

5. EQUAL POSSIBILITIES TO USE PUBLIC TRANSPORT

Analysis of possibility for disabled persons to use the public transport system is carried out in Lithuania in 2007. Research work is based on the analysis of the situation in the state and questioning of public transport operators, transport co-ordination institution, government institutions and the disabled persons' organizations [6, 7].

The analysis of situation shows that the main purpose and tasks are as follows:

- to focus more attention and to separate finances to modernization of transport means and transport infrastructure;
- to investigate, to determine the way how transport infrastructure has to change at increasing number of people with special needs.

The analysis must appeal to the usage of current special means for disabled persons in the process of movement and travelling by public transport and also to the achievement in sciences and new technologies for rapid spread of subsidiary means. Though the analysis and the identification of present situation show that worldly known achievement in sciences and technologies haven't reached Lithuania yet. It is a lack of technical means (even older models) for elder and disabled people: with motor impairment – mechanical wheelchairs (in future – personal auto-chassis); with hearing impairment – deaf-aids (in future – bio-implants); with visual impairment – voice signals (in future – simulated eyes); with disorientation impairment – (in future – personal orientation GPS equipment) in Lithuania [8].

Technical means for the development of movement of people with special needs are oriented to the development of compensatory technique.

The development and the improvement of communication system are related to the restoration of public mobility. Transport means and infrastructure are intended to be arranged for harmonizing social services with economic benefit. Technical and informative solutions are advantages. Operating staff in transport sector have to be prepared to serve people with special needs. Expenditure of these services is subsumed in general expenses of the activity. Therefore service subjects of transportation system have legal claims for the state compensations.

Individual and public adjustment of the meeting and satisfaction of disabled persons needs have to be sustainable for the purpose to eliminate the social disjuncture. Community is responsible for the meeting of each member needs without social discrimination. It is important to ensure compatibility and interaction between individual and public compensation means (legal, economic, finance and other aspect).

The government and transport operators are responsible for the accessibility of transport system for all groups of passengers. Since rural and urban passengers have different needs it is seeking to develop

public transport system harmoniously in technical and organizational levels and to combine individual transport means with route transport. A part of transportation services can be covered by computerized communication technologies. Creatable system of information community will help to do it [9].

The accessibility of transport infrastructure for disabled persons is big trouble in transport sector. The accessibility of footpaths, lanes and spaces to public transport stops and stations, parking fields, platforms for disabled persons is concerned with objective projection or reconstruction of transport infrastructure. State institutions and transport operators are responsible for it. The accessibility of transport system for elder and disabled persons is regulated with specific requirements by national legal acts and technical standards.

On the national organizational level the main institutions responsible for issues of disabled persons is Ministry of Social Security and Labour and Lithuanian Council for the Affairs of the Disabled to the Government of the Republic of Lithuania. The Secretary to the Ministry of Transport and Communications is a member of the Lithuanian Council for the affairs of the disabled persons.

Main legal acts in context of social integration of the disabled persons are as follows:

- The Constitution of the Republic of Lithuania;
- Law on social integration of the disabled persons;
- Law on transport privileges;
- Law on financing of programme of roads maintenance and development;
- Law on non-motorized transport;
- Bicycle lanes development programme 2003-2012;
- Government programme for 2001-2004;
- Governmental resolutions on specially adapted transport supply to mobility reduced disabled (every year about 10 special vehicles are purchased to districts' Associations of disabled);
- Order of the Minister of environment No. 317 of 14 June 2001 on technical regulation STR 2.03.01:2001 - Constructions and territories. Requirements for needs of the disabled persons;
- National programme of the integration of the disabled into the Society for 2003-2012, approved by Government resolution.

According to the National programme of the Integration of the disabled into society for 2003-2012 Ministry of transport and communications (in the sphere of it responsibility) has to implement following measures:

- Preparation of draft legal acts for above-mentioned Government programme's implementation;
- Organization of scientific and research works for the Integration of the disabled persons into society;
- Collection of statistical data on changes of the Integration of the disabled persons into society;
- Public awareness enhancing;
- Preparation and implementation of the Governmental programme in order to adapt transport and public state and local roads for needs of the disabled persons and preparation of financing rules;
- Recommendations for suppliers of information and communications services on Adaptation of information environment for the disabled persons.

The main measures of environment adaptation for disabled people have to be included in and yearly implemented by the transport system development plan:

- Constructions of lanes for walking and cycling:
- Construction of lifts for the disabled persons in railways;
- Adaptation of buildings environment for needs of the disabled persons (construction of WC, special pavements instead of steps and automatic doors control in the post offices, bus stations, airports, Vilnius railway station and other transport and communications buildings);
- Renewal of cities bus parks, with low-floor busses, implementation of "Yellow bus" programme (school buses are adapted for the disabled children);
- Rules of road traffic include articles for drivers of vehicles signed "Disabled" appropriate privileges for parking, use of streets, where motor transport is banned;
- Prepared bicycle lanes development programme 2003-2012.

Accessibility guidelines. Sustaining interrogation of representatives of disabled persons and specialists, the priority means of public transport and infrastructure adaptation for disabled persons with special needs are the following:

1) to adapt passenger transport information system for disabled persons and people with limited movement;
2) to implement intermodal coherences of different types of public transport adapting for disabled persons;
3) to guarantee the accessibility of all public routes for disabled persons and people with limited movement;
4) to enable attendant person travel together with disabled person;
5) to locate special information for disabled persons in transport objects;
6) to equip passenger terminals with special motorized wheelchairs having indoor guidance information system and enough space for luggage and loadings for people with motor impairment;
7) to equip transport objects with automatic doors, ramps and lifts, un-slippery floors, moving paths and elevators; sound, sensory and visual marked paths, toilets and terminals accessible for disabled persons;
8) to equip transport means with ramps and elevators for suitable boarding of people in wheelchairs or with crutches, also armrests and strengthen elements for wheelchairs and crutches;
9) to guarantee safety seats for people with special needs and also prompt assistance (WC, medicine, water, blankets and etc.);
10) to inform disabled passengers about their arrival, transfer stop/ station and travel peculiarities with special care;
11) to equip substations and stops with special infrastructure and necessary information for disabled persons;
12) to train public transport drivers and other staff to serve disabled persons;
13) to build bicycle paths suitable for people in wheelchairs specially in rural areas: suburbs, small towns and villages;
14) to build platforms suitable for disabled persons near car parking sites, public buildings, shopping centres and apartment buildings.

These mentioned priority means are necessary to be installed in buses, plains, train vans, ship cabins, all kind of passenger terminals, stops, infrastructure (pavements, crossings, traffic-lights regulation) of the main streets with public transport routes [9].

Accomplished interrogation proved that the implementation of these projected means is necessary for the following:

- for systemic collection of primal information – statistic data about social integration changes of disabled persons;
- to prepare and realize analysis programs on problems having influence on disabled persons and their families living;
- for adaptation of physical (public) environment – to adapt the environment of education and training, health care, public objects and social institutions for disabled persons;
- to prepare and realize program in national significance and local roads on transport and infrastructure adaptation for disabled persons; to prepare finance methods;
- partly adaptation of transport service for disabled persons, analysis of their movement needs, formation of routes ensure equal rights for disabled persons;
- it is purposeful to employ an autonomy principle for satisfaction of disabled persons needs leaving general planning and public finance for state institutions;

Accessible environment for disabled persons will eliminate social disjuncture and allow them participate in fully-fledged public life.

CONCLUSIONS

1. The number of disabled persons in Lithuania is increasing from year to year amounting to 7% of the population in total. Among the major reasons leading to disabilities, diseases of circulatory failure, connective tissue and musculoskeletal system, tumours, traumas and mental disorders may be prioritised.

2. Disabled persons enjoy the same rights as other members of the society, they are provided with the same opportunities for education, employment, recreation, participation in public, political and community life. Only in cases when the same conditions and measures are ineffective, special measures are designed for improving the situation of the disabled persons.
3. The main goal of the Law of the Republic of Lithuania on social integration of the disabled persons is to ensure equal rights and opportunities for the disabled persons in the society, to define principles of social integration of the disabled persons, to determine the system of social integration, the preconditions and terms, as well as the institutions in charge of the implementation of social integration of the disabled persons, the assessment of disability and working capacity level, the provision of services in occupational rehabilitation, and the principles for the identification and meeting of special needs of the disabled persons.
4. Municipalities are assigned to establish the level of special needs of the disabled persons. The level of special needs for these persons is set based on information provided by other services within their competence.
5. The aim of the Programme of social integration of individuals with disabilities is to create the conditions and equal opportunities for the disabled persons to participate in the public life. For the implementation of this programme considerable attention was paid to the spheres of provision of social services to the disabled persons and the adaptability of the environment, employment and rehabilitation.
6. According to the National programme of the integration of the disabled persons into society for 2003-2012 Ministry of Transport and Communications has foreseen to implement main specific objectives. The main measures of environment adaptation for disabled people have to be included in and yearly implemented by the transport system development plan: development of transport infrastructure, tracks and lifts for disabled persons, adaptation of buildings environment of stations and terminals, renewal of cities bus parks and railway coach fleet, adaptation of traffic control system for disabled persons with special needs.
7. Since the routes of public transport are not adapted totally for passengers with special needs and even more, there is no implement the intermodal public transport system for passengers in Lithuania, for this reason the public transport operators have lost the increasing client market.
8. Results of questioning show the problems of systematisation and co-ordination common efforts and funds for the meeting the special needs of passengers with disability. Improvement of the separate units of technical environment for adaptation for disabled people doesn't give the possibility to harmonize all complicate system to the sustainable operating structure.

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RESEARCH OF THE PROBLEMS THAT INTERMODAL TRANSPORT FACES IN EUROPE

Ilona Jaržemskienė[1], Andrius Jaržemskis[2]

Vilnius Gediminas Technical University
Transport Research Institute
Plytinės 27, Vilnius-16, LT-10105, Lithuania
Phone: (+370)52370605. Fax: (+370)52370555.
[1]E-mail: ilona@ti.vgtu.lt
[2]E-mail: andrius.j@ti.vgtu.lt

The article is based on analysis of the intermodal transport bottlenecks in EU. The consequences as well as reasons are described. Road freight grew in Europe in last thirty years dramatically. The tools that are used for modal shift mostly are focused on liquidation of the consequences and not the reasons. The analysed issues are collected from many research works and official European documents. The list of systematised bottlenecks is the output of the article. The conclusions of the article formulate very clear outlook – what the bottlenecks are and on what researches, political decisions and business implementations the researchers should be focused.

Keywords: intermodal transport, freight transport

1. INTRODUCTION

Intermodal transport is the well known way to reduce transport costs, pollution and congestion. Intermodal transport is defined as transportation of intermodal transport units that are containers, semi-trailers and swap bodies. The road transport operates marginal sections of intermodal transport chain mostly, because there is a lack of companies that are placed near by railway or sea/river port. This way of transportation is very well promoted in USA and EU. The linguistic definition of this transportation is different in countries and regions in past 20 years. We could meet multimodal, bimodal, trimodal, kombi, mixed etc. definitions of this transportation. The last definitions intermodality and modal shift are replaced by a new word 'co-modality' in Europe since 2007.

Liberalisation in world trade, extension of European Union, crucial developments in information technologies and decreasing transport costs all of it has a growing impact on globalisation. Production facilities are located in South-East Asia. Costs of transportation, warehousing, inventory holding are responsible for 10–15% of the final product costs. China displaced the United States as the largest source of EU imports in 2006. Role of to EU is also becoming more important. During 2005 EU-India trade increased by 20.3%. These facts provoke new challenges for transport and the main of them are the following: freight transport is growing faster than GDP, increase in road freight transport influence congestion and road problems with safety, rail and inland waterway transport loose market share, EU's target to reduce CO_2 emissions by 20% in 2020 and dependency on fossil fuels.

The aim of the article is to analyse researches produced and the documents issued by the bodies of European Union as well as freight operators that are related to problems in intermodality and prepare common list of intermodal bottlenecks in EU. The following chapter is based on analysis of literature selected in References [1–28]. The good intentions to systematise the bottlenecks in one paper was the open letter of IRU organisation in 2003. The list is elaborated in the article much deeper.

2. THE MAIN PROBLEMS FOR INTERMODALITY DEVELOPMENT IN EU

The first figure shows distribution of freight transport flows among transport modes in EU and USA. The second one presents comparison of distribution of freight transport flows in Europe in 1970 and 2000. The share of road transport increase in 14 percent points and share of the sea transport increase in 5 percent points. The opposite figures we found in rail and inland waterway sector. The railway freight decrease in 12 percent points, waterway – decrease in 4 percent points during the same time period. Growing market for freight transportation provokes increase of road transportations dramatically.

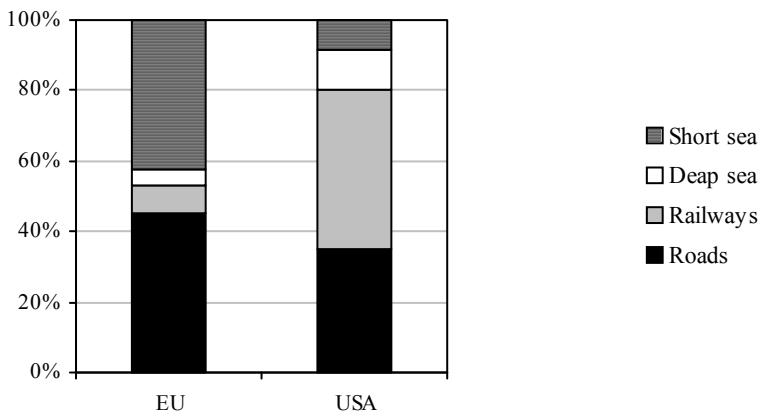

Figure 1. *The distribution of freight flows in EU in the US*

The rail transport play leader role in the United States when it's third only in EU. The history of railway construction in the US and Europe is quite different. The railways in the US are built on the basis of private investments. The entrepreneurship is very well developed in that sector in comparison with Europe, where the main railway lines in various countries are built by government's finances, i.e tax payers. The railway operators are also the owners of infrastructure in the US. The freight transportation by railway is the core business of railway companies. The railway due economy of scale compete very well with road transportation. For many years the railway passenger transport is being the priority in Europe and not the freight. Thus, naturally, it is difficult to compete with truck when the level of priority is only the second one. This is the reason why the US lead in rail based intermodal decisions in comparison to EU.

The economy of scale is the main driving force for intermodality. If we analyse intermodal transportation of containers, we also find advantages in the US. The power of trains in the US is diesel engine basically when in Europe – electricity. Electricity is a strong ecological toll, but the height of train is restricted. So in the US the containers are moved in two levels whereas in one level in EU. It is not difficult to calculate that capacities of intermodal trains are twice higher in the US. The capacities in EU are more restricted than in the US in length and weight as well.

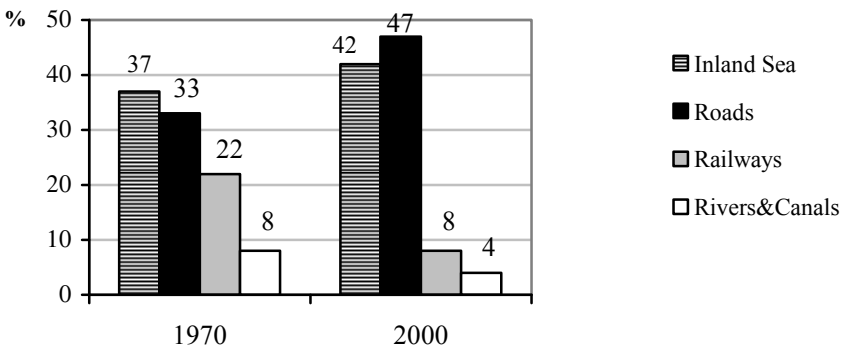

Figure 2. *The distribution of turnover of freight transportation in Europe*

The main accent in promotion of intermodal transport in EU is drawn in environmental area. Pollution, congestions and accidents are important issue for revising situation and supporting intermodal decisions. Environmental aspects of course are a strong tool for politicians, and for public opinion but business talk in money language. The need of stronger economical promotion aroused at the moment in Europe. The promoters of intermodality should to understand this focus and implement it. The business sectors are not satisfied, when intermodal decisions come from the top, i.e. from the politicians. The education, training and promotions in intermodal transport should be economically targeted first of all. Environmental issues of course may play the role, but this role should be second for business.

Today road carriers, forwarding agents and logistics suppliers or, to use the jargon coined by Brussels, "freight integrators", are the main players in the shaping of combined transport. They have the equipment and maintain relations with the shippers. The railway, inland waterway and short sea shipping companies are subcontractors in the intermodal chain [1].

There is a variety of intermodal transport markets in Europe each of which has specifically peculiarities. Some times intermodal transport ideas presented by politicians are not competitive to road transport. It is important that intermodal transport to find and to fix the niche in the market. One of the market niches is shipments of maritime containers arriving in the European ports Hamburg, Bremerhafen, Rotterdam, Antwerp, Le Havre, Marseille, Genua, Gióia Tauro etc. This freight is distributed in Europe mainly by short sea shipping or by rail. Distribution of maritime containers by road only takes place over distances less than 500 km or in cases, where the containers are brought to or fro the port at the last minute. The other market niche is transportation of tank containers. Wherever possible, these are conveyed in combined transport. All tank containers, which can move combined, make use of rail/road possibilities, and no political initiatives are needed to persuade road transport operators to use the rail infrastructure. The most new private rail operators come from this sector. Unaccompanied transport of swap bodies and semi-trailers is the third niche of the intermodal market. The distance of transportation, frequency, time of delivery and the price is the main competitive factors in this niche. Exactly this market is loosed in Europe against truck services because the railways didn't understand how they should go about their role in the international chain [1]. As long as the railways, as monopolies with a dominant position, do not look after their rail haulage services, but devote more time and resources towards consolidating their general market position; the level of intermodality in semi-trailers and swap bodies market will be low.

The next reason for a lack of intermodality could be assumed as a lack of punctuality of freight trains. Delays up to 24 hours became the norm. Delays are the only cap of the iceberg. The core is lack of understanding about volumes of negative effect inspired by delays. According CIM provisions under which trains, in principle, can be delayed for up to 7 days before compensation has to be paid. The railways suggest compensations but not changes. Various kinds of subsidies are given to intermodal transport. Compensation and subsidies are focused to decrease consequences but not the reasons. Punctuality problems of freight railways arise because of passenger trains priority against freight in Europe. In case of accidents, and failures of timetables the passenger trains are rescheduled firstly. The freight trains are moved in time where free time window is obtained.

The lack flexibility of railways in timetables, capacities and prices is the other bottleneck for intermodality. The prices in the market fluctuate in various seasons of the year, but railways do nothing to meet the market conditions. Next problem accrue because there is a lack of equipment that is suitable for combined freight transport. Investment in intermodal equipment is not a first priority of national railways of the Member States.

Figure 3. *The Lack of intermodal equipment*

The intermodal transport within Europe by containers meets the bottleneck because of different standards of technical equipment. The ISO containers do not match to Euro-Pallets. The width of the container is 2.33 meter, and measures of EPL are 0.8x1.2 meter. Seven centimetres are missing for rational loading of containers by goods on the pallets. In comparison trailer loading capacity is 33 or 34 EPL per unit. ISO 40'container loading capacity is 25 EPL. The crucial difference allows trucking of the trailer to be leading transport in Europe.

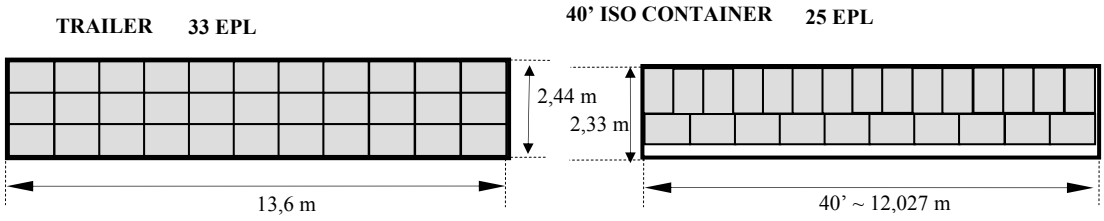

Figure 4. *The capacities of trailer and 40' ISO container*

The other problem that meets intermodal transport is regional differences in Europe. The economical gap between regions inspire different price of workforce. This means that trucking prices per kilometre is different in various regions, e.g. Scandinavia and the Baltic Sates or the Baltic States and the UK. For this reason trailers that carried by railway and/or ferry are companied with trucks and drivers as well. At the moment to send the truck with driver from a new member state is cheaper in comparison to buy trucking service e.g. in Scandinavia and/or the UK. But additional eight tons of track weight does not match the ecological and economical background of intermodality as a whole system. Additional eight tons is more than 60 percent of average weight of freight in trailers that was 13 tons per trailer in 2006 in Klaipeda port. The possibility that was analysed is to locate own trucks in Scandinavia and/or the UK but there are cabotage restrictions. According EU law this restriction should be cancelled in 2012. As bad practice of intermodality we found Turkey-Italy intermodal connection by ferry. Trailers are carried accompanied with truck by ferry. Drivers of these trucks are sent by bus via Balkans to meet their trucks.

The economical tool that could promote intermodality in Europe should be labelling of intermodal services. When trailer is trucking by road to and fro port or to and fro inland intermodal terminal some economical discounts for road fees, increased weight limits should be introduced in the legal framework in EU.

Negative effect of road transport is calculated as external transport costs. In many countries external costs are not evaluated correctly today. The road fees, fuel taxes and environmental taxes are a toll to cover that costs, but it is various measures in EU. Common policy of calculation should be used in whole Europe. The railway transport is economically more effective than road due economy of scope if we compare operational cost. The whole amount of infrastructure cost of railways is covered by railway operators today. Infrastructure costs of road transport are covered by commercial operators as well as by private users and tax payers.

CONCLUSIONS

The main reasons of lack of intermodality in Europe are the following:

- To low share of private investments and entrepreneurship in railways;
- Capacities restriction in railway transport;
- Wrong segmentation of the core players of intermodal transport;
- Failure in market segmentation;
- Punctuality problems in railway transport;
- Lack of flexibility in schedules, prices and capacities in railway transport;
- The political initiatives are focused to consequences and not to reasons;

– The gap between technical standards e.g. Euro-pallets don't match for the ISO containers;

– Because of regional differences in workforce price and cabotage restriction the trailers are moved accompanied with the trucks. Transportation of additional weight of truck discredits intermodal solution;

– There is a lack of economical discounts or reduction of restriction for trailers that are carried within intermodal chain. Intermodality labelling for trailers is needed.

– There is a lack of common understanding and common policy of internal transport costs in EU.

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