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Editorial Notes

Transport and Telecommunications are two global technologies that play the leading role in the world today. The creation of the unique European transport area is ensured by their development in the considerable degree. Our edition is one more afford on the way of speeding up of this process.

The aim of the journal is to acquaint the reader with the national experience of various countries in the fields of transport and telematics applied researches as well as with the working materials of the European thematic networks and the research projects in this area.

For example, this special edition is devoted to the experience of Lithuanian researchers in transport sector.

We hope that our edition will be interesting to the wide range of the researchers, academics and professionals, and we invite all interested persons to take part in the forming of its information politics.

Igor Kabashkin

Editor-in chief

THE THEORETICAL AND PRACTICAL ESTIMATING OF THE ACTIVITY OF INTERNATIONAL FREIGHT TRANSPORT

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Abstract: There are described practical and theoretical estimating of the activity of the international freight transport .There is showed short analysis of the new computerised customs transit systems for Europe, described what is the advantages of the system for transportation and customs and here are present most typical objectives of dynamic management of international freight transport.

Keywords: international freight transport, transport activities, theoretical research, estimating, the new computerised transit systems.

1. Introduction

With the aim to increase the attraction of Lithuania as a transit country it is necessary to identify the main obstacles in the field of border crossing and formalities of customs procedures.

Basing on the formulation of objectives of management of international freight transport activities it will be possible to perform detailed research of incoming international transport means activities distribution according to the time and their distribution in separate customs lanes. Basing on the analysis of the new computerised transit systems for Europe it will be possible to improvement new simplified procedures in customs.

Formulation of international transport activities, analysis of new computerised customs transit systems and presenting typical objectives of dynamic management of international freight transport flows enables elaboration ways for the improvement of customs inspection by introduction of lines for cars carrying freight of special groups, thus also diminishing to minimum the idle tome in customs. On this basis it is possible to identify measure for solving the problems of busiest customs-houses, thus positively influencing Lithuanian economy and enabling a more precise view of customable freight carrying transport means inspection with the present number of customs officials.

2. Theoretical estimation of international freight transport

At each time moment t the state of the process of movement of international freight transport flow is characterised by n phasic coordinates $x_1(t)$, ..., $x_n(t)$, here $x_i(t)$ – the amount of the flow remaining on the peak i at the time interval $[t,\ t+1]$. Thus at every moment t the phasic state $X(t)$ has n coordinates:

$$X(t)=\left(x_1(t),\ x_2(t),\ ...,\ x_n(t)\right).$$

The object state sequence $X(0),\ X(1),\ ...,\ X(T)$ at the moments $t=0,\ 1,\ ...,\ T$ is called the trajectory of the movement of the object.

We will manage international freight transport flow movement at each time t moment selecting m managing parameters $U(t)=\left(u_1(t),\ ...,\ u_m(t)\right.$, here $u_j(t)$ – amount of flow starting to move along the pane j at t time moment.

The sequence of points is called the management $U(1),\ U(2),\ ...,\ U(T)$. We introduce restrictions to management field and to phasic coordinates.

It is considered that the possibilities of the pane capacity and capacity of stores at the peaks are the functions of the time t and incidental factor ξ. Let us indicate:

$$f(t,\ \xi)=\left(f_1(t,\ \xi),\ ...,\ f_m(t,\ \xi)\right) \text{ and}$$
$$l(t,\ \xi)=\left(l_1(t,\ \xi),\ ...,\ l_m(t,\ \xi)\right).$$

Accordingly the vectors of capacity possibilities and the lower margin at the moment t, specifying a permissible management field, and

$$g(t,\ \xi)=\left(g_1(t,\ \xi),\ ...,\ g_n(t,\ \xi)\right)$$

store capacity vector specifying restrictions to phasic coordinates [1–3].

Then, in the network of international freight transport flows, we shall formulate the optimal management issue as the stochastic issue of optimal management of discrete object:

$$J_0(X,\ U,\ t)\to max; \tag{1}$$

$$\Delta X(t)=\varphi(U,\ t),\quad t=\overline{0,\ T-2}\ ; \tag{2}$$

$$l(t,\ \xi)\le U(t)\le f(t,\ \xi),\quad t=\overline{0,\ T-1}\ ; \tag{3}$$

$$X(T)\le g(t,\ \xi),\quad t=\overline{1,\ T}\ ; \tag{4}$$

$$\left.\begin{array}{l} X(t)\ge 0 \\ U(t)\ge 0 \end{array}\right\},\quad t=\overline{0,\ T}\ . \tag{5}$$

And the set of initial states $X(0)$ – is put:

$$X(0)=X^0,$$

here (1) – criterion of management efficiency; (2) – management of the movement of a managed object; (3) – permissible management range; (4) – limitations for phasic coordinates; (5) – non-negativity of phasic variable and managing parameters.

By the stochastic model (1)–(5) it is possible to define a great class of international freight transport flows optimal management objectives.

Let $\beta\|b_{ij}\|$ be the transport network G matrix of peak-pane incidences, whereas $b_{ij}=-1$, if the pane j goes out from the peak i and $b_{ij}=+1$, if the pane j goes into the peak i. The matrix β^{+} is obtained also changing the negative elements of β by zeroes, and $\beta-$ changing positive elements with zeroes. Then discrete managed object which is defined by the conditions (1)–(5) will be described in the network of dynamic flow in proportion to the respective parameters:

$$X(t+1)=X(t)+B^{+}U(t)+B^{-}U(t+1),\quad t=\overline{0,\ T-2}; \tag{6}$$

$$X(T)=X(T-1)+B^{+}U(T-1); \tag{7}$$

$$X(0)=X^{0}; \tag{8}$$

$$l(t,\ \xi)\le U(t)\le f(t,\ \xi); \tag{9}$$

$$X(t)\le g(t,\ \xi),\quad t=\overline{1,\ T}; \tag{10}$$

$$\left.\begin{array}{l}0\le X(t)\\ 0\le U(t)\end{array}\right\},\quad t=\overline{0,\ T}. \tag{11}$$

Here we will present three most typical objectives of dynamic management of international freight transport flows.

1. *The objective of maximum dynamic flow in the network*. It is necessary to maximise quantities of the flow delivered to the destination point per T time moments. Formally the essence of the objective is that knowing the initial state (8) we chose such permissible management (9), (11) for the object (6, 7, 10, 11), which gives maximum meaning to the functional $J_0(X,\ U,\ t)$. In this issue the criterion is:

$$X_n(T)\to max. \tag{12}$$

Initial conditions in this issue will be presumed in the following shape $X^0=(\infty,\ 0,\ ...,\ 0)$. Sometimes additional conditions are assumed that the whole flow going out from the peak 1, will reach the destination peak n at T time periods. To fulfil this condition we shall presume $g(T)=\{\infty,\ 0,\ ...,\ 0,\ \infty\}$.

2. *The objective of minimal cost*. Let $R(t)$ be the cost vector of carrying of a flow unit along the network panes at the time moment t. It is necessary to minimise the notion:

$$\sum_{t=0}^{T=1}\left(R(t),\ U(t)\right)\to min \tag{13}$$

limitations being (6, 11).

Initial conditions have the shape:

$$X^0 = (x,\ 0,\ ...,\ 0),$$

here x – the extent of flow to be carried along the network G. In order that the whole flow could reach the peaks n, it is necessary that:

$$g(T) = \{0,\ 0,\ ...,\ 0,\ x\}.$$

Without this precondition it may be stated that:

$$g(T) = (0,\ \alpha_2,\ \alpha_3,\ ...,\ \alpha_n),$$

when $0 \le \alpha_i \le x$, $\sum \alpha_i = x$.

3. *Minimisation of the flow extent filling in the dynamic set of panes*. Let us select in the network G the minimum extent dynamic flow from 1 to n at T intervals time filling in the panes from $\Omega(t)$ and meeting the conditions (6)–(11). The criterion of the objective is as follows:

$$X_n(T) \to max, \tag{14}$$

whereas $l(t;\ \xi) = f(t;\ \xi)$ for all panes from the set $\Omega(t)$. Initial conditions are:

$$X^0 = (\infty,\ 0,\ ...,\ 0) \quad \text{and}$$

$$g(T) = (\infty,\ 0,\ ...,\ 0,\ \infty).$$

According to the contents this issue is interpreted as an objective of identification of a minimal number of transport means with the aim of ensuring the transport traffic according to the schedule, organising the carriage by all transport modes except pipeline transportation.

3. Analysis of new computerised transit systems

The advantages of the new computerised transit system for trade. The system offers traders many advantages, including:

- Improved quality of service:
- Less time spent waiting at customs, because the declaration will have been sent electronically beforehand;
- Greater flexibility in presenting declarations.
- Earlier discharge of the transit procedure because an electronic message is used instead of the return of the paper copy No 5 by mail. leading to a faster release of the guarantee.
- The high costs, incurred in relation with the paper-based system of declaring goods (lengthy procedures involving much time and effort), are reduced.
- A greater clarity of the transit operation, for the benefit of trade.

- Because customs will have decided well in advance of the arrival of the goods at the office of destination whether or not they want to check the consignment, the trader will not lose valuable time at the office of destination waiting for a decision.

Apart from these general advantages for trade, there is an additional advantage for authorised consignors linked to the new computerised transit system. They no longer have to carry out the cumbersome formalities that are necessary in a paper-based environment, because all the movements will be directly managed by the system.

The advantages of the new computerised transit system for customs. The communication and coordination between the customs administrations involved will improve.

- Repetitive activities will only have to be performed once; this saves time and eliminates the risks involved in the duplication of information.
- Creation of a more coherent system, which will speed up the processing of data and at the same time making the system more flexible.
- Harmonisation of operating criteria, which will do away with the plethora of subprocedures and divergent interpretations of how the rules have to be implemented.
- Availability of a system run directly by customs, which offers greater security and a higher tempo in managing transit, provides more reliable data and better monitoring of movements.

It is clear that the trader indirectly benefits from the advantages of the new computerised transit system for customs, and vice versa.

In principle all traders can use the new computerised transit system. It is only necessary to use the electronic data interchange (EDI) procedures which have been established for the communication with customs in order to be connected to the new computerised transit system.

Customs will have to:

- install computer infrastructure, or adjust their existing facilities, to meet the specific needs of the new computerised transit system, including compatibility with the Common Communication Network (CCN/CSI);
- set up an organisation to keep the computer applications running (Helpdesk);
- formulate and develop measures to ensure that the new computerised transit system is integrated into the existing procedural and organisational set-up;
- devise and introduce suitable training for customs staff and traders.

Operation. Before going into the details it is useful to mention the main items and messages in a new computerised transit system operation.

- The transit declaration, which is presented in a paper or electronic form.
- The movement reference number (MRN), which is a unique registration number, given by the system to the declaration to identify the movement.
- The transit accompanying document, which accompanies the goods from departure to destination.
- The 'anticipated arrival record' message, which is sent by the office of departure to the declared office of destination mentioned in the declaration.
- The 'anticipated transit record' message, which is sent by the office of departure to the declared office(s) of transit* to notify the anticipated border passage of a consignment.
- The 'notification of crossing frontier' message, which is sent by the actual office of transit used after having checked the consignment.

* An office of transit is a customs office situated at one of the external land borders of the EU or one of the other participating countries of the Common Transit Convention.

- The 'arrival advice' message, which is sent by the actual office of destination to the office of departure when the goods arrive.
- The 'control results' message, which is sent by the actual office of destination to the office of departure after the goods have been checked.

Furthermore it is important to understand that the system covers all the possible combinations of normal and simplified procedures, at departure as well as at destination.

Office of departure. The transit declaration is presented at the office of departure, either in paper form (in which case the data is introduced in the system by the customs office – see Figure) or in a computerised form (see Figure 1, as well as Figure 2 in case the simplified procedure is being used). Electronic declarations can be made from terminals made available to traders at the customs office of departure or from a trader's own premises.

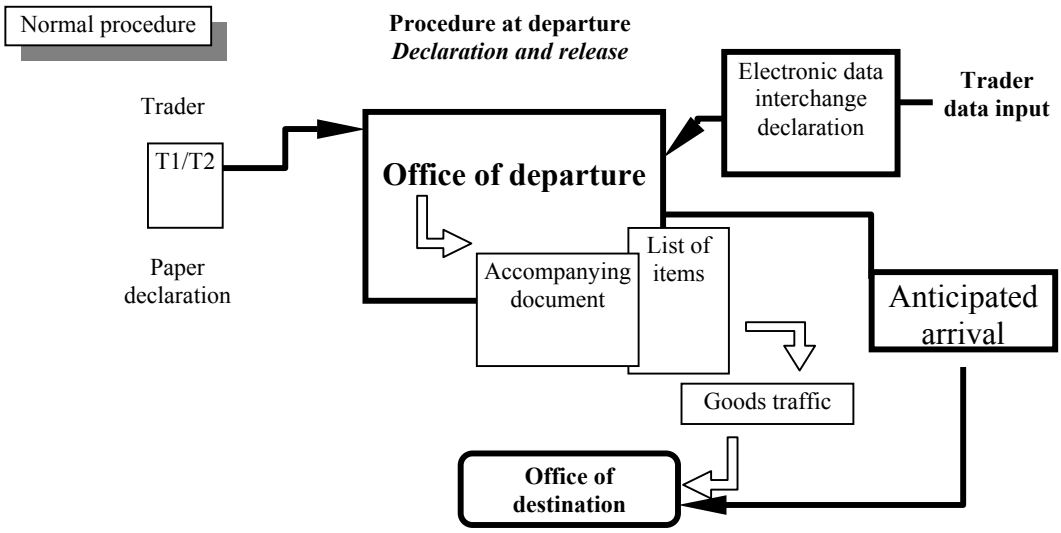

Figure 1. Office of departure – Normal procedure

Whatever the form of the presentation, the declaration must contain all the data required and comply with the system specifications, since the system codifies and validates the data automatically. If there is an inconsistency in the data the system will indicate this. The trader will be informed, so that he can make the necessary corrections before the declaration is finally accepted.

Once the corrections have been entered and the declaration is accepted, the system will provide the declaration with a unique registration number, the movement reference number.

Then, once any inspections have been carried out, either at the office of departure itself or at the authorised consignor's premises, and the guarantees are accepted, the goods will be released for transit. The system will print the transit accompanying document and, where appropriate, the list of items, either at the office of departure or at the authorised consignor's premises. The accompanying document and the list of items must travel with the goods and be presented at any office of transit and at the office of destination.

When printing the transit accompanying document and the list of items, the office of departure will simultaneously send an anticipated arrival record to the declared office of destination. This message will mainly contain the information taken from the declaration, enabling the office of destination to control the consignment when it arrives. The office of destination needs to have

access to the best possible information about the transit operation to take a correct and reliable decision about what actions to take when the goods arrive.

Should the movement have to pass an office of transit, the office of departure will also send an anticipated transit record, so that any office of transit has prior notification of the consignment concerned and can check the passage of the movement.

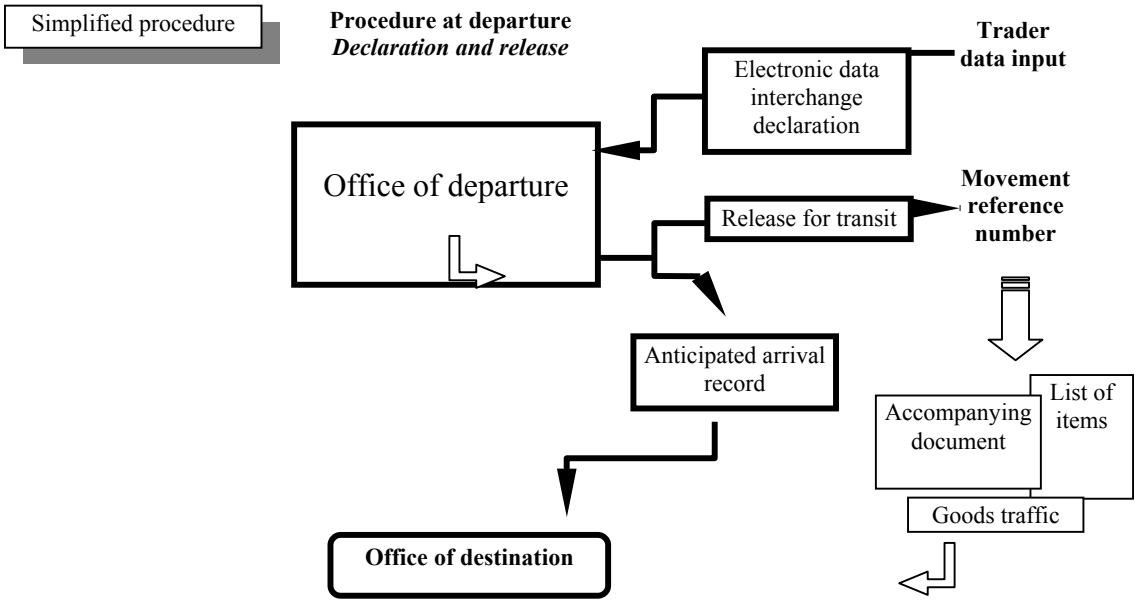

Figure 2. Office of departure - Simplified procedure (authorised consignor)

Office of destination. Upon arrival, the goods must be presented at the office of destination (either indirectly via the authorised consignee or directly) together with the transit accompanying document and the list of items, if appropriate (see Figure 3, and Figure 4 in case of the simplified procedure). Customs, having already received the anticipated arrival record will have full details about the operation and therefore will have had the possibility to decide beforehand what controls are necessary.

When they enter the movement reference number into the system, it will automatically locate the corresponding anticipated arrival record, which will be used as a basis for any action or control, and send an arrival advice message to the office of departure.

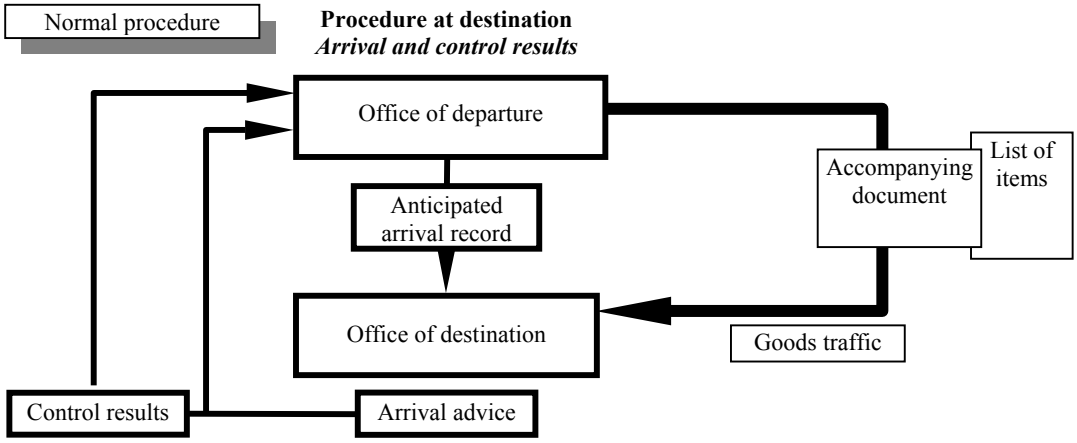

Figure 3. Office of destination - Normal procedure

After the relevant controls have been carried out, the office of destination will notify the office of departure of the control results by using a control results message, stating which, if any, irregularities have been detected.

The control results message is necessary to discharge the transit operation and free the guarantees that were used for it.

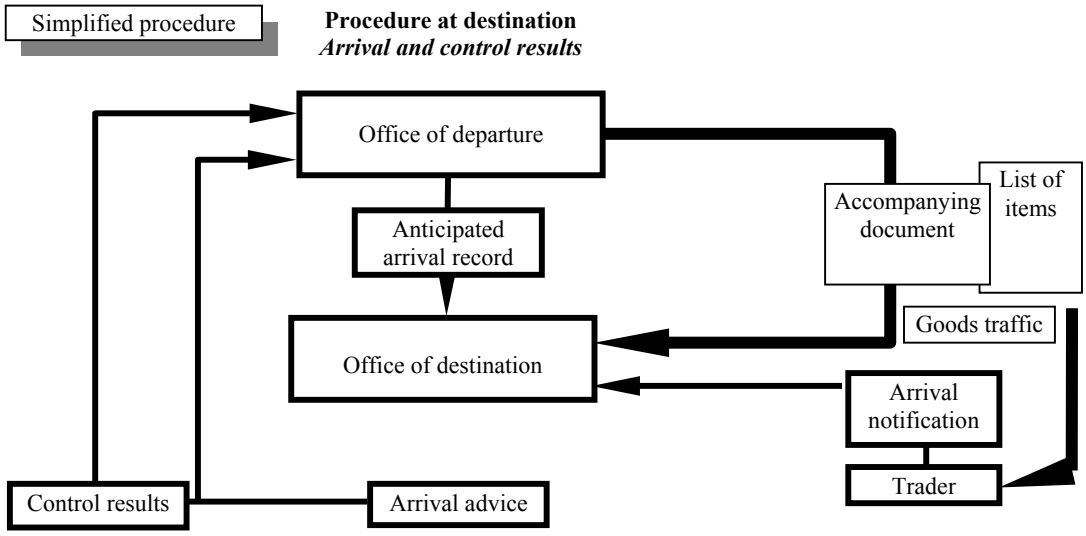

Figure 4. Office of destination -Simplified procedure (authorised consignee)

Office of transit. When the goods pass by an office of transit, the goods, the transit accompanying document and, where appropriate, the list of items have to be presented to customs. The anticipated transit record, already available in the system, will automatically be located when the movement reference number is entered and subsequently the movement may be approved for passage. A notification of crossing the frontier is sent to the office of departure.

Change of office of transit or destination. If the goods go via an office of transit other than the declared one, the message that had initially been sent to the declared office of transit is of no use. In this case the actual office of transit will send a message to the office of departure, requesting the anticipated transit record, so that it can access the relevant information. Having checked the movement it will send the notification of crossing the frontier to the office of departure.

Likewise, the goods can be presented at an office of destination, other than the declared one. The actual office of destination will request the office of departure to send the anticipated arrival record so that the new office of destination may obtain the necessary information on the consignment.

If there is a change in office of transit or destination, the messages which have been sent to the declared offices are of no use and will remain open. To this end, the system will automatically send a message to the declared offices, notifying them where and when the goods have been presented, so that they can close the messages.

Simplified procedures: authorised consignor and authorised consignee. The use of both simplified procedures represents the optimal use of resources within the framework of the new

computerised transit system. The possibility of carrying out all the procedures at one's own premises and exchanging information with customs electronically is clearly the most rapid, comfortable, secure and economic way of doing business.

Obviously in addition to satisfying the normal criteria to become an authorised consignor or authorised consignee, they will have to possess an adequate electronic data processing system for information interchange with their relevant customs offices. Of course this can only work if these offices are connected to the new computerised transit system.

Once these criteria have been fulfilled the new computerised transit system allows authorised consignors to:

- create the transit declaration in their own computer system;
- send the corresponding declaration message electronically to the office of departure without the goods having to be physically presented there;
- send and receive by electronic means subsequent messages, including requests for correction of the declaration, notification of its acceptance and notification of the release of the goods.

As far as authorised consignees are concerned the new computerised transit system allows them to:

- receive the goods and the accompanying document directly at their own premises;
- send the arrival notification message to the relevant office of destination electronically;
- receive and send subsequent messages concerning permission to unload goods and the notification of the results of the unloading to customs electronically.

These advantages really make the new computerised transit system the transit system of the future [5].

4. Conclusions

- Basing on the assessment of formulation of the objectives of management of transport flows and on the indeterminacy of external impacts, it is possible to carry out a more detailed analysis of the distributions (according to time) of flows of transport means entering customs, as well as their distribution in to separate customs lanes. It also enables the definition of dependency on the extent of transport flow, as well as allows the calculation of choosing optimum transport amount for the inspection in customs-houses during a certain period of time [4].
- Basing on the formulation of objectives of management of international freight transport activities it will be possible to perform detailed research of incoming international transport means activities distribution according to the time and their distribution in separate customs lanes. Basing on the analysis of the new computerised transit systems for Europe it will be possible to improvement new simplified procedures in customs.
- On this basis it is possible to identify measures and means of solution of the busiest customs-houses, thus enabling positive impact to Lithuanian economy, as well as to make more relevant assessment of the inspection of transport means (carrying customable freight) performed by a present number of staff.

References

[1] Zhan F.-B., Noon Ch.-E. Shortest Path Algorithms: An Evaluation using Real Road Networks. *Transportation Science*, Vol 32, No 1. February, 1988, p 65–73.

[2] Transport of fast Changing Europe. Vers un Reseau European des systems de transport by Group Transport 2000 Plus. Brussels, 2000. 90 p

[3] Baublys A. Introduction to the theory of transport system. V.: Technika, 1997. 298 p (in Lithuanian).

[4] Jarasuniene A. (2002) Formulation of optimal international freight transport objectives. Vilnius: Technika, 2002, 201 p.(in Lithuanian).

[5] New customs transit systems for Europe. European communities, 2001. Belgium. 2001. 55 p.

TRANSPORT OF LITHUANIA IN THE PROCESS OF INTEGRATION INTO THE EUROPEAN UNION

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The article analyses the topical problems of Lithuanian transport sector restructuring and development in the context of the integration into the EU. Main tendencies and perspectives of the sector's reforms are surveyed in the article. Also there are presented opportunities of separate transport modes and principal provisions of the development.

Much attention is paid to the analysis of modernisation and development strategy of Lithuanian transport infrastructure by relating it to the policy of connection\extension of Trans-European transport networks to the EU candidate countries in the frame of TINA network development. Implementation of this strategy is illustrated by concrete investment projects of the development of European transport corridors on the Lithuanian territory, by emphasising the importance of regional co-operation programmes with the neighbouring countries.

The authors give the review of the main aspects of the chapter "Transport policy" of the Lithuanian – EU negotiations. They stress the importance of the EU transport policy impact on the long-term national transport sector strategy. In more detail the authors present the results of their analysis of the impact of the implementation of the latest EU railway directives in the Lithuanian railways.

1. Introduction

Analysis of Lithuanian transport history shows [1] that until 1918 the construction of roads and railways, as well as the operation of inland transport waterways has been determined by the political and economic reasons of the Czarist Russia.

In 1940 Lithuanian transport was nationalised. The railway, air and maritime transport became subject to the Soviet Union. Lithuania partially controlled only the road and inland waterways transport.

Therefore, during the soviet period (1940–1989) the railway, maritime, air and pipeline transport was developed and operated regarding the political and economic objectives of the former USSR. Apart from the railway transport, the development of maritime and air transport was fairly sufficient, also the establishment of the pipeline transport was quite a positive fact. However, from the geopolitical point of view Lithuania thus became bound up with Russia. At that period the road transport and roads were developed best of all.

After the declaration of independence of the Republic of Lithuania the whole transport sector became a component of Lithuanian economy and its social infrastructure. The following transport branches comprise the Lithuanian transport system: railway, road, maritime, inland waterways, air, urban electricity and pipelines. At present the development of the system is basing on the provisions of the Lithuanian transport policy.

Essential restructuring of transport modes has been started with the view of implementation of the main goals of the Lithuanian transport system – i.e. the integration into the Baltic Sea region and the European transport network as well as into the transport services market.

Irrespective of complicated problems of the transitional period of that time the transport sector succeeded in functioning reliably, in principle satisfying the consumers needs for passenger and freight transportation. Early in 1994 the Government of Lithuania approved the National Transport Development Programme up to the year 2010, which defined the basic trends of the national transport policy, the main of which are the following:

- integration into the European transport network and transport services market, with the priority of the development of internationally important transport corridors;
- creation of the national legal system regulating transport activities and harmonisation with the legal standards applied in the European Union;
- active participation of the State in ensuring the stable functioning of the transport infrastructure objects as well as their reconstruction and development by attracting necessary investment resources;
- demonopolisation and privatisation of the State transport sector providing commercial transport services, promotion of private investment.

The National Transport Development Programme received a positive evaluation by foreign and Lithuanian experts as well as by international transport institutions. The main Lithuanian multimodal corridors I and IX were approved at the 2nd Pan-European Transport Conference in Crete. It is important to note, that in the concept of the Pan-European transport network extension, which was worked out during the Conference in Helsinki, the above mentioned corridors in the territory of Lithuania remain unchanged. This created favourable conditions for Lithuania to further develop the transport system including all modes of transport.

The essential restructuring of the Lithuanian transport sector had been started before the National Programme was adopted by implementation of new institutional methods corresponding to the market conditions. One of the most important aspects of the institutional reforms is demonopolisation and privatisation started in Lithuania at the end of 1991. In the process of the first stage of privatisation (till the year 1995) more than 120 enterprises of different transport modes were privatised. At that time a number of new private transport enterprises was increasing rapidly, especially in the road and maritime transport sectors. This created favourable conditions for competition, which was ensured by respective legal measures.

The commercial activity was started on the basis of the principle that the costs shall be covered from the operational income. For that reason the public financing of commercial transport companies was gradually decreased up to discontinuation, with the exception of subsidies provided for public service obligations.

It is foreseen in the National Programme that the strategic objects of transport infrastructure are functioning on the basis of public ownership. Under implementation of the policy of taxes and charges for using these objects, the accumulated finance is being used to cover the expenses of maintenance and renovation of the infrastructure. For the implementation of infrastructure modernisation and development projects the direct public investments are allotted or the state gives its guarantee to the International Financial Institutions for the credits to be obtained.

2. Railway transport

Currently the operational length of the Lithuanian railways makes 2001.8 km. From which 1811 km make 1520 mm gauge, 21.8 km – 1435 mm gauge, and 168.8 km – 750 mm gauge lines. There are 565.6 km of double track railways, 122 km of which are electrified. Broad gauge railway network in Lithuania is sufficiently dense, the rate is 31 km per 1000 km^2 of

territory. However the density of operational network does not always indicate the quality of transport services. The railway network is not optimal, it lacks double track routes, certain cities are left without railways at all.

As the Lithuanian railways are starting to operate under new conditions determined by the market laws, it is very important to take advantage of their convenient geographical position and to seek the most benefit from the transit transportation. For this reason there are fixed transit transport corridors the railway lines of which are adjusted to intensive traffic demands. Under formation is the West – East corridor linking the Baltic Sea ports Klaipeda, Kaliningrad with Belarus, the Ukraine, Russia and the countries of the Far East. The railway lines of this corridor have quite sufficient technical parameters. However, the aim to reach international standards requires works of vast investment. In the section Kaisiadorys – Siauliai – Klaipeda (about 300 km) the construction of the double track should be finished and the automatic blocking system should be installed. These are very expensive works (about 140 million EURO). However, after their finalisation, it would be possible to satisfy the transit transportation demands as well as to improve the ecological situation.

The South-East corridor through Sestokai should link the Western Europe countries with the Baltic States, Finland and the northern part of Russia. Formation of this corridor has many specific peculiarities. Firstly, it plays the role of the gate to the European gauge railway. Secondly, it is the European high-speed route through Kaunas, Riga and Tallinn to Helsinki. Therefore, while making technical solutions, it is necessary to assess duly these important factors. In the first stage of joining the European gauge railway, the freight handling terminals in Lithuanian – Polish border (Sestokai and Mockava) were established. In the second stage it is planned to extend the European gauge railway line to Kaunas and to establish there a modern freight distribution centre. Together with Latvia, Estonia and some other European countries, Lithuania is aiming at implementation of modern high speed train which will enable the passenger trains to reach the speed of 200 km/h.

In the course of integration of Lithuanian railways into the European transport system, along with its network improvement, it is necessary to modernise essentially its operational activities: to renew the rolling stock, to establish effective rolling stock maintenance depots; to install automatic, communication and information systems; to improve passenger service and to implement other measures of safe and comfortable traffic.

It is not a big technical problem to increase the speed of passenger trains up to 160 km/h – it is rather an economic issue. The current construction of railway tracks wholly meets the requirements for such trains, however their technical condition and traffic management system require improvement. Such main lines should be electrified, as the usage of other sources of energy does not allow the trains to reach a high speed. With the view of higher than 160 km/h speed of trains there should be significantly reinforced, replaced switches, readjusted train admission platforms, to improve traffic regulation systems. For high-speed trains with the speed higher than 200 km/h it is advisable to construct separate rail lines adjusted exceptionally to the high-speed traffic.

3. Maritime transport

After Lithuania and other Baltic states regained its independence, the situation on the Eastern Baltic Sea coast changed. Freight flows of East – West direction decreased mostly on the basis of the political reasons. Afterwards, during the several years of independence the freight flows from East to West and from West to East started to increase again. In 1992, by the

Governmental decree of the Republic of Lithuania the Klaipeda seaport was awarded the status of the State seaport. There was established Klaipeda State Seaport Authority (KSSA) responsible for the whole infrastructure.

At present, the Klaipeda port water area and quays are being dredged. Following scientists' recommendations it is foreseen to dredge to the depth of 14 m. In connection with the development of the port we encounter acute environmental problems. With the view of preservation of ecological system of the Curonian Lagoon and prevention of fresh and salt water mix, there are performed various calculations and simulation.

Currently at the Klaipeda State Seaport there are operating nine specialised stevedoring companies, three shiprepair yards and a shipbuilding yard, also there are several scores of freight forwarding, shipping agencies and other enterprises providing port services and other related services. They all perform commercial activities in the port, and the KSSA co-ordinates all the activities of the port, takes care of infrastructure modernisation and development, and ensures safe shipping in the port.

Among these enterprises the *JSC Klaipedos Nafta* plays its proper role – it is a modern specialised oil products terminal able to handle 7–8 million tons of oil and its products.

One of the largest stevedoring companies of the port is the *JSC KLASCO Klaipeda Stevedoring Company* handling almost a half of all freight in the port (about 8 million tons). The company has a terminal for bulk freight with the quays of up to 14 m depth, sea ferry and Ro-Ro terminal, there is also a modern container terminal capable of handling up to 150 thousand TEU per year.

Bega Stevedoring Company is developing particularly actively. This company specialises in handling of mineral fertilisers, cement and other dry goods. The company handles up to 2.5 million tons of freight, it has advanced handling equipment, covered warehouses for 160 thousand tons of goods.

Consortium "*Klaipedos Terminalas*" is also operating in the port. It is a private wide profile stevedoring company receiving at its quays the Ro-Ro type ships and handling 25 thousand trailers, 20 thousand TEU containers, other general freight.

JSC Klaipedos Smelte specialises in the handling of foodstuffs, fish products, other refrigerated production, scrap-iron, fertilisers, timber. The company rapidly renovates its infrastructure and superstructure, as well as the freight handling equipment.

Klaipeda seaport receives yearly about 7000 ships from approximately 50 countries. Yearly about 17 million tons of different freight is handled in the port. The main share of it make oil products, metals, fertilisers and refrigerated products, timber, grain, fodder, sugar, containers, scrap-iron, cement. Already now the port is able to handle about 21 million tons of freight per year.

4. Roads

Seeking to integrate the Lithuanian road network into the Trans-European network the international highway Tallinn – Riga – Kaunas – Warsaw (Via Baltica) is under construction. Apart from the Baltic States, other countries such as Finland, Sweden, Poland are participated in the project implementation. By its technical parameters this highway would allow the high speed of transport means, it would also enable to absorb a certain part of transit freight, passengers, tourist flows between Scandinavian and the CEE countries, i.e. in the North –

South direction. The 274 km long Via Baltica route was designed in Lithuania by making use of existing roads. They are reconstructed by building by-passes of towns and settlements, by increasing the quantities of lanes, by construction of bridges, double-level crossings.

The Via Baltica construction and reconstruction is carried out in two stages. The first stage is already finished. There are constructed: Kaunas western by-pass, Kedainiai eastern by-pass, Panevežys by-pass. The following sections are under the reconstruction: Pasvalys – Latvian border together with several by-passes. There is opened Kalvarija border crossing between Lithuania and Poland. With the growing transport intensity, in the second stage, the existing road is further under modernisation – by extending it to four traffic lanes, by construction of two level crossings. It is foreseen to finish the works of the second stage by 2004, on condition the financing is sufficient.

The highway Lithuanian/Byelorussian border – Vilnius – Klaipeda is included into the international road network of East – West direction. 4-lane section of the road Vilnius – Klaipeda is under reconstruction, the pavements being strengthened and traffic safety means being implemented. For an efficient functioning of this road it is planned to construct the southern Vilnius city by-pass.

Main issues of the road network development until 2010 include the improvement of technical and traffic safety parameters.

Together with the development of road network the roadside infrastructure is taken care of more attentively, particularly on the highways and other arteries of international transportation. It includes equipment and construction of rest sites, gas-stations, technical service stations, motels, hotels, cafes, shops, telephone communication and emergency service. Development of these objects is basing on private investments.

5. Road transport

Road transport is adjusted to work under the market conditions. Management of road transport enterprises has been decentralised, large and composite enterprises have been decomposed, freight transport enterprises have been privatised, road transportation licensing system has been implemented, other State regulation provisions have been implemented.

Aiming at the improvement of public transportation service and freight transportation, as well as by vast application of modern logistics methods of transport management and advanced technologies and enginery – all this serves the implementation of Lithuanian road transport economic and legal reform, technical modernisation of transport means and infrastructure.

In 1994–1996 there has been privatised the long distance and local (suburban) transportation by buses. 40% of bus fleet operating in urban routes has been renewed by purchasing buses of higher capacity and meeting EU technical and ecological standards.

In 1994–1996 bus stations were separated from the bus fleets and rearranged into independent legal units. The bus stations' functions are developed by providing various services to passengers and tourists, by improving local advertising, by transportation of small size consignments.

Basing on the research of international and local freight flows there are implemented the principles of more efficient participation of freight transport in the market of multimodal transport services, its more rapid introduction into the logistically based freight transportation. There are reconstructed existing terminals and constructed new ones for freight handling,

storage and trailer parking. Also there are established freight forwarding structures in the main Lithuanian multimodal transportation hubs with the interface of road, railway and waterborne transport.

In the end of 2001 in Lithuania there were registrated 1.3 million transport means, from which 1.1 million make private cars (since 1996 their number increased 1.5 times), 110 thousand freight vehicles and 15 thousand buses. In the end of 2001, 726 carriers had licenses for long distance and international passenger transportation and 3491 carriers received the licenses for international freight transportation.

With the growth of fleet of transport means the traffic intensity increases too – in 2001, in the main Lithuanian roads it grew by 28.3%, if compared with 1995, and in some sections of the roads it reached 15 thousand transport means per day. At the same time the speed of vehicles grew too, as well as their weight and axle loading. There emerged congestion problems caused by the increase of private cars as well as by the growth of transit traffic. Surfaces of numerous transport arteries and those of national roads are not able to withstand the increased overloading, which results in occurrence of splits, undulation\roughness and other defects as well as ruts causing danger for traffic safety particularly on wet surface.

One of the problems of most topicality still remains the high casualty and accident rate. In the Western Europe, during the last 25 years, the casualty rate decreased from 80 thousand to 50 thousand per year in spite of the doubled amount of vehicles during that period. Particularly in Scandinavian countries the casualty rate has decreased – it became 2.5 times less.

Meantime in Lithuania the situation was developing otherwise: in 1991 the casualty rate reached its peak – there were registered 6067 accidents with 1093 casualties, and 6638 injuries. Later on the rate of accidents was stabilised and diminished. However in 1996–1997, with the further growth of vehicle quantities and traffic flows, it increased again. In 1996 the casualty rate equalled the rate of 1986.

Since 1994 in Lithuania (following the methods used in the Western Europe) there was started accumulation of data on the “black spots” of the national roads. The experience of western countries has demonstrated that elimination of accident reasons, i.e. “black spots” on the national roads, enables the decreasing of accidents up till 1.5 times.

In 1997 there was started the implementation of a special traffic safety programme aiming at elimination of the “black spots”. This programme received a particularly great attention and financing in 1999 – then EUR 8 million was allocated for the means of the programme. Presumably it is that basing on this investment that the casualty rate decreased significantly in 2000. However, if compared with the European and Global situation, the traffic safety in Lithuania still remains unsatisfactory.

6. Air transport

At present there are 4 international airports in Lithuania, 3 of which (Vilnius, Kaunas and Palanga) are included into the TINA network.

Vilnius airport is the state-of-the-art and the largest airport in Lithuania. It is situated 6 km from the city centre. However, in comparison with the regional airports of the Western Europe, it may be considered only as a medium size. The runway of Vilnius airport is 2500 m long and 50 m wide, its capacity – about 32 aircraft and 700 passengers per hour. The airport handles the main share of international flights and it is the biggest airport of Lithuania regarding the

passenger handling. In 2001 there were 17 277 incoming and outgoing flights, 585 thousand passengers and 5 thousand tons of freight were handled.

The runway of Kaunas airport is 3250 m long and 45 m wide. The capacity of the airport is 6 aircraft and 200 passengers per hour. Freight flights make the greatest share of flights to Kaunas airport. Freight is mainly transit. In 2001, 4190 aircraft have departed and landed in Kaunas airport, 20 137 passengers were serviced and 9.5 thousand tons freight were handled (56.3% of the overall national freight transportation by air). The perspectives of the airport are related to the development of chartered freight flights and to the development of activities of the Kaunas free economic zone.

Palanga airport is situated 28 km North from Klaipeda. The runway of the airport is 2000 m long and 40 m wide. The capacity of the airport is 6 aircraft and 200 passengers per hour. In 2001 the Palanga airport has handled 2361 aircraft, 45 660 passengers (since 1996 increased by about 1.4 times) and 70 tons freight. Palanga airport operation is mostly aiming at the passenger service thus inducing the development of resort and tourist services and satisfying the demands of the rapidly developing Klaipėda region.

The number of aircraft using the air space of Lithuania is constantly growing and in 2001 it has reached 72.4 thousand of which 2\3 were transit. National carrier is represented by 2 air companies – the *JSC Lithuanian Airlines* and its subsidiary *JSC Air Lithuania*, making regular flights from Vilnius, Kaunas and Palanga airports.

The infrastructure of Lithuanian airports and air space control systems are rather well developed, but the existing capacities are not used in full, the equipment of airports safety and security is not developed enough.

7. Development of the Lithuanian transport infrastructure in the context of the European transport policy

Lithuania, while developing and reforming its transport system, alongside with the national needs, also refers to the common European transport development objectives and guidelines. These are being identified and amended in the yearly conferences of the European Ministers of Transport, Pan-European Transport Conferences as well as by the Commission of the European Union (EU) and Economic Commission of the United Nations (UN ECE).

The Ministry of Transport and Communications of Lithuania and different transport institutions participate in the activities of International organisations and special working groups implementing guidelines of the Common Transport Policy for Europe.

Common European policy for transport network development is being established. Specific quality and design standards for international transport network elements are defined in the European Agreements on traffic in the main transport arteries: road (AGR), railways (AGC), inland waterways (AGN) and combined transport (AGTC). The most important international transport lines and main standards (which need to be followed in the process of restructuring of used and newly constructed elements of transport network), are defined in these documents by mutual agreements. The European Parliament and Council adopted, in July 1996, a Decision on Community guidelines for the development of the Trans-European transport network. The Decision comprises the guidelines covering the objectives, priorities and measures envisaged in the sphere of development of Trans-European transport network (TEN-tr.) and brings together, in a single framework, the outline plans for road, rail, inland transport, port and airport networks. The guidelines form the basis for the identification of projects of common

interest permitting gradual integration of the networks at European level. The member States are being determined the precise details of projects, their routes, financing and the speed of implementation in accordance with national planning rules and the subsidiary principle. It is estimated that at least 400 BEUR will have to be invested over the next 15 years to complete the TEN-tr.

Specific measures and plans for further European transport development perspectives were prepared by joint efforts of the UN/ECE, European Commission and ministries of transport of Central Europe (including the Baltic States). The results of the long-term activities were generalised during the Pan-European transport conferences, which took place in 1991 (Prague), 1994 (Crete) and 1997 (Helsinki).

The third Pan-European Transport Conference, held in June 1997 in Helsinki, underlined the need to connect the EU transport infrastructure network to the accession countries and considered the concept of a European Transport Infrastructure Networks partnership. Especially this partnership is important with respect to technical work and financing of projects related to transport infrastructure, interoperability and the use of intelligent transport systems along ten Pan-European Transport Corridors.

In addition, the European Agreements with the countries of Central and Eastern Europe (CEEC) contain provisions on transport infrastructure, particularly with regard to the management and modernisation of road, rail, port, airport and inland waterway infrastructures on the main routes of mutual interest as well as on the Pan-European Corridors. The connections of these countries with the Community network is therefore a Community priority in the context of the pre-accession strategy.

In this context we have devoted particular attention to the Transport Infrastructure Needs Assessment (TINA) Programme, the main objective of which is to assess transport infrastructure needs in Central European countries, to identify projects of common European interest and to define the future Trans-European Transport network (TEN-tr.) in the enlarged European Union. In order to monitor the TINA programme, the EU Commission has established a Group of Senior Officials (The Group) including all Member States and 11 candidate countries for accession.

The Group was required to assess jointly the common transport infrastructure needs in 11 Central European countries, with the aim of developing a common multimodal transport network, linking this part of Europe and the existing European Union (EU). This should provide the infrastructure necessary to allow transport throughout the enlarged Union, consistent with the objective of sustainable mobility, as well as meeting transport needs for trade with the countries outside the EU. This network, which was defined by applying the TEN-tr. concept to the candidate countries for accession, will become a part of the enlarged EU Trans-European Transport Network, on the basis of the provisions of Article 129 d of the EU Treaty. The EU Commission will use the TINA Report prepared in the year 2000 to draft the necessary proposals for the approval of the Council and the Parliament.

The definition of the TINA network is based on a certain number of assumptions:

- the network should be in line with the criteria of the EU guidelines for the development of TEN-tr. (Council Decision 1692/96/EC);
- technical standards of the future should be in line with the recommendations of the UN ECE Working Party on Transport Trends and Economics on the definition of transport capacities, to ensure consistency between the capacity of network components and their expected traffic;

- the time horizon for achievement of the network should be the year 2015;

The TINA network has evolved from two sources:

- a backbone is identical with the links and nodes of ten multimodal Pan-European transport corridors on the territory of Central European countries, as endorsed at the Third Pan-European Transport Conference in Helsinki (1997);
- additional network components were approved by the TINA Group after the assessment of proposals by each TINA country, according to the TEN-tr concept and on the basis of cost estimates.

The method proposed for the common assessment work of the TINA Group is structured into three steps. Step 1 dealing with the backbone network and Step 2 with the additional network components. Step 3 carries out project assessment. Generally speaking by steps 1 and 2, on the basis of proposals received from countries (in the framework of the above mentioned 2 sources) the TINA network was established, as well as identification and assessment of possible investment measures, applying the recommendations of the UN ECE Working Party on Transport Trends and Economics on the definitions of transport capacities, using rough traffic scenarios and cost estimates given by the country administrations and based on unit cost figures. Step 3 is built on the two first steps and prepares the implementation of the TINA network. Possible investments, identified in the previous steps, have been assessed as regards their priority for the network. Those identified, as necessary for the realisation of the EU network by the year 2015 will be further defined and ultimately developed as projects and assessed. This step will generate a set of viable projects to be proposed for implementation during the period until 2015.

Lithuanian transport policy was clearly oriented towards integration into the European transport system since 1990, the year of regained Independence of the country. Due to this we do not face any substantial problems while orienting the transport investment programme towards the objectives of TINA.

In the medium term (up to the year 2006) 55 transport infrastructure investment projects (envisaged in the National Transport Development Programme) are planned to be implemented, 43 of which are directly related to the development of the Pan-European Transport Corridors. Main investments are directed at the rehabilitation and modernisation of railway infrastructure (45%), reconstruction of roads (31%), development of Klaipeda Seaport (15%) and international airports (5%). It should be noted that existing infrastructure, already accommodating growing passenger and freight flows (including transit flows), is being improved under international standards. These projects are in line with the priorities for the development of the transport networks, set out in the above mentioned European Parliament and Council Decision 1692/96/EC:

(a) establishment and development of the connections, key links and interconnections needed to eliminate bottlenecks, fill in missing sections and complete major routes;

(b) establishment and development of infrastructure for access to the network, making it possible to link island, landlocked and peripheral regions with the central regions of the Community;

(c) the optimum combination and integration of the various modes of transport;

(d) integration of environmental concerns into the design and development of the network;

(e) gradual achievement of interoperability of network components;

(f) optimisation of the capacity and efficiency of existing infrastructure;

(g) establishment of and improvement in interconnection points and intermodal platforms;

(h) improved safety and network reliability;

(i) the development and establishment of systems for the management and control of network traffic and user information with a view to optimisation of the infrastructure use;

(j) studies contributing to improved design and better implementation of the trans-European transport network.

Table 1. Conformity of the Anticipated Lithuanian Transport Investment in Middle-term (up to the year 2005) with the Priorities of European Transport network development

Applicability by mode (the total number of investment projects in each mode is shown in brackets)					
Priority	Rail (24)	Road (15)	Seaport (12)	Air transport (4)	All Modes (55)
Number of projects to which this priority applies					
(a)	24	13	10	–	47
(b)	3	5	5	2	15
(c)	2	2	4	–	8
(d)	6	7	11	–	24
(e)	2	–	4	–	6
(f)	22	11	10	4	47
(g)	2	–	4	–	6
(h)	23	15	10	4	52
(i)	8	–	3	2	13
(j)	2	3	4	–	9

The most important priorities and objectives, which form the basis for preparation of Lithuanian transport infrastructure projects are as follows:

- improvement of traffic safety;
- optimisation of capacity and efficiency of existing infrastructure;
- construction and development of missing links.

The implementation of the TINA programme will enable gradual approximation of Lithuanian transport infrastructure (by joint efforts of the neighbouring countries) to the technical standards of the EU member states and will demonstrate the ability of the country to become an efficient member of the EU. Of course, substantial financial resources will be needed, as well as joint efforts of transport and other institutions of the country, which are responsible for transport infrastructure development. When forecasting the financial resources of TINA, the importance is given to direct state financing (alongside the financial support from EU funds and credits and from International Financial Institutions, also involvement of private capital). It is recommended, in line with the methodology for preparation of the TINA programme, for each country to allocate 1.5% of GDP for implementation of the above programme.

We have prepared calculations of Lithuanian transport infrastructure development and modernisation needs up to the year 2015. TINA programme includes:

1158 of railways (the total cost is estimated 948 MEUR;

1608 km of roads (607 MEUR;

Klaipeda State Seaport (588 MEUR);

Vilnius, Kaunas and Palanga airports (141 MEUR).

The estimated cost of these transport infrastructure objects comprises 2328 MEUR.

It should be noted that Lithuania is actively implementing the projects, within of Pan-European transport corridors.

The Via Baltica highway project can serve as a good example of how the progress is made in transport corridor development. Since regaining the independence in 1990 the Baltic States were considering the implementation of the project for about 5 years. Many declarations on its realisation were signed. However the problem remained unsolved. It nearly failed.

The situation has changed virtually when this project was acknowledged as a constituent part of the 1st Pan-European Transport Corridor (Crete, 1994).

In 1995, a High Level Working Party of Via Baltica consisting of authorised representatives from Sweden, Finland, Baltic States and Poland prepared a specific five year investment plan (up to the year 2000) for implementation of the project. Financial sources were found. It is important that project financing is supported by EIB, EBRD, NIB and other international financial institutions (IFI).

In 1996 Lithuania was the first country (among countries which took part in this project) to secure the full financing at a five-year programme for Via Baltica using loans from IFI and local financing (Road Fund). In 1996 the Lithuanian Government signed loan agreements for construction of the highway Via Baltica.

In the end of 2000, the implementation of the first Via Baltica highway five-year investment programme was completed. In the Ist stage of the programme the rout was considerably improved. In this programme the priority was given to essential rehabilitation of the roads comprising the Via Baltica route for which Lithuania invested 72 million USD. Significant increase of transport amounts (16–43%) demonstrates the efficient utilisation of the investment. Long distance traffic indicates/reflects/underlines the importance of the Via Baltica route as the international transport route. During the period of five years the cross-border traffic extent grew in the following proportions: Estonia – Latvia, 30% for all transport means (60% for trucks); Latvia – Lithuania, 50% for all transport means (90% for trucks).

However, the implementation of the First investment programme shows that the input of different countries into the improvement of the main direction of the common corridor varies by comparative indices. Assessment of the initial technical condition of the state of the roads (1996) demonstrated the differences of investment deposits (USD/km) more evidently. For instance, the common/general length of the main part of the Via Baltica in the territories of the three Baltic States/countries makes 665 km, 29% of which (193 km) belong to Estonia, 30.6% (204) – to Latvia, 40.3% (268 km) – to Lithuania.

In the end of the First investment programme the medium/average level/rate of investments proportions as follows:

- in Estonia – 253 000 EUR/km;
- in Latvia – 153 000 EUR/km;
- in Lithuania – 268 000 EUR/km;
- in Poland – 176 000 EUR/km.

To avoid the underestimation of the efforts of all the countries, however, it should be noticed that according to the opinions of the road users the present/current traffic conditions in the territory of Latvia are by significantly worse.

Therefore, it is very important for the countries to strive to the unification of the traffic conditions during the implementation of the Second investment programme (2001–2006).

On the other hand, the planned Second investment programme will not complete the reconstruction of the Via Baltica and rehabilitation in its entire\whole length (through the Baltic states – 665 km and through Poland – 340 km). There may still emerge discrepancies not possible to co-ordinate within the time limits of the proposed investment programme. The incongruity of certain stretches with the required norms will be a serious obstacle and will cause problems to the growing traffic in the Via Baltica highway. Therefore, Lithuanian side is interested in putting all possible efforts to the Via Baltica highway reconstruction and rehabilitation in the whole length of the Via Baltica Corridor, as well as to the timely implementation of the planned second stage and to the proper utilisation of the EU supplementary support means in the period of 2004–2006.

The Lithuanian interests in the development of the Pan-European Corridor No. 1 are not limited only by the Via Baltica project. The construction of the European gauge railway from the Lithuanian/Polish border, near Mockava, to Kaunas, and a freight handling centre in Kaunas has been defined as the main goal of Lithuanian transport policy to connect Lithuania with Central and Western Europe by a direct railway link. Kaunas is intended to be developed as Lithuanian freight handling centre, in which the interface between broad gauge, European standard gauge and road transport will be concentrated, by integrating the most modern telematics concepts. The establishment of the above logistics centre will provide an opportunity to serve road transport cargo units transported by long distance railways, or, in other words, to develop combined transportation in Lithuania.

We have started the preparation of economic evaluation for route selection for the Polish border – Kaunas section of European gauge project, in order to start detailed construction planning.

We believe that this project will be important not only to Lithuania, but also to the countries of Western and Central Europe, since it will provide technical preconditions for the railway companies of the above countries to participate in the railway and combined transport services market of the Baltic States. On the other hand, broad railway market of Western countries will be open to the Lithuanian railways (having in mind implementation of regulations of free access to the European railway network). It is also very important that, after implementation of this project, operators of our country will have favourable possibilities to maintain their high position in Europe (under existing conditions of increasing international competition), since development of combined transport is one of the major priorities of the EU transport policy.

Construction of the European gauge railway from the Polish/Lithuanian border to Kaunas depends on the success of the regional co-operation in the entire Baltic Sea region.

To achieve the desired development of Pan-European Corridor No. I there are several economic, institutional and interoperability barriers in addition to technical problems concerning development of infrastructure. Particularly with the neighbouring country – Poland – it is necessary to solve these problems, to harmonise national strategies. Lithuania has already managed to reach agreement in principle with Poland for implementation of this project. Both sides have already agreed on the border crossing point of the European railway as well as on the location of border railway stations.

Special axles, with the wheels that can take two or three positions and be fixed in one of these, are used for the transition from one gauge to another. The fixing mechanism loosens, while

passing the gauge change device (at the speed up to 20 km/h), wheels take the position corresponding the gauge and then are fixed again automatically.

The trial tests of the highly efficient and economical DB Cargo system, developed by German railways, were performed. The advantage of such system is that not only the axle-wheels, but also the wagon braking and coupling systems are unified too. It allows the European gauge wagons to proceed while attached to their trains by the Baltic railways.

The gauge change device is easy to install on the stone ballast; it is suitable for the coaches as well.

The operational tests have begun and 7 specially equipped wagons have already started carrying freight between Lithuania and Poland. If the results of the completed operational tests are positive, the number of wagons might be increased to satisfy the expansion of the freight flows. The length of the routes will increase adequately\correspondingly. The manufacturers (or the intermediaries) will be given the possibility to purchase such wagons as well.

Also coaches are being tested in parallel, and therefore 6 Polish coaches were equipped accordingly. 6 Lithuanian coaches are planned to be equipped in the year 2001.

A crucial requirement for the future of this corridor project is performance indication of future operators on the corridor in this highly competitive market. The estimated potential cargo will have to be won through better performance parameters and higher value logistic services than on existing routes. This is a very complicated issue\problem\question with very many uncertainties and the level of technical services offered will be crucial to competitiveness.

The points of transfer between modes are the weakest links in the current intermodal transport system and the major generator of friction costs. One reason is the lack, or inadequacy of technical interoperability between modes and loading units. Another reason is that the present-day terminals, which are usually marked by a combination of heavy engineering and manual processes, are not managed efficiently with appropriate telematics support.

We believe the Kaunas Logistics hub will be a 21st Century intelligent intermodal junction of two TEN-tr Corridors (I and IX) and an interconnection of two major railway gauges. It will integrate state-of-the-art telematics concepts and information systems (TEN-Telecom), to exploit the potential for vastly improved quality of transport services and added value in transport logistics.

Active modernisation and investment policy is maintained in Klaipeda, another important transport hub, which is directly connected with the IXB Pan-European transport corridor. Priorities are given to the modernisation of the Klaipeda Port infrastructure, by constructing new and reconstructing the existing quays, deepening the port water area, reconstructing the infrastructure of the Port entrance.

The activities of Klaipeda transport hub (logistics centre) arc to be based on the implementation of efficient traffic flows management, information and telecommunication system (crucially, in providing transit services) to increase the use of capacities of Klaipeda Seaport and associated rail and road infrastructure of Pan-European Corridor IXB.

It is necessary to note that at present the investment priorities (about 2/3 of all transport infrastructure investment) are given to reconstruction and modernisation of those transport infrastructure objects, which coincide, with the components of transport network within the TINA concept. The total annual investments into the infrastructure reach over EUR 100 mln.

Today we can state that implementation of measures for the development of TINA network would allow to reach gradual technical compatibility of the Lithuanian transport infrastructure with the Trans-European Network. Unfortunately, the present financial possibilities of the State do not allow to increase the finance of investment projects significantly, aiming at the implementation of TINA measures foreseen until 2015. Therefore Lithuania pays great attention to the implementation of ISPA in transport sector by elaborating suitable projects for the utilisation of funds of this Instrument.

Worth to emphasise, that development of corridors and other crucial transport links is not just an improvement of infrastructure. Plausible institutional framework required for operations is of no less importance. Reliability of transit transport system is facilitated by further implementation of strategic plans on restructuring of transport undertakings, liberalisation of markets as well as by enforcement of measures on traffic safety and environmental protection.

In connection with the Lithuania's accession to the EU, significant attention is being directed towards the implementation of the Transport *Acquis*. At present Accession Partnership priorities are given to the adoption of legal acts in the spheres of market access, regulation of social conditions, harmonisation of fiscal policy, traffic safety and transportation of dangerous goods.

Currently about 80% of Transport *Acquis* have been transferred to the national law. Up to January 2004 Lithuania anticipates to adopt and implement all legal acts of the EU.

International transport activities are based on intergovernmental agreements, requirements and regulations of international transport organisations and conventions.

Since 1992 up to the present moment Lithuania has concluded 87 bilateral and multilateral agreements with 39 states of EU, Central European, CIS and other countries. Among them:

- Road transport – 35 agreements with 39 countries;
- Civil Aviation – 29 agreements with 28 countries;
- Railways – 12 agreements with 9 countries;
- Waterborne Transport – 11 agreements with 10 countries.

For the time being the Republic of Lithuania or separate Agencies of the transport sector are members of 18 major international transport organisations, they have joined 35 multilateral conventions and protocols. Our country is represented in such important international organisations as ECMT, IMO, ICAO, IRF, UIC, ECAC, IATA, etc.

Speaking of the consequences of restructuring, without any doubts it must be stressed that this process has served a good basis for the reorientation of the Lithuanian transport sector towards the activities in new conditions. Lithuanian companies have managed to operate under competitive pressure in the dynamic market of transport services. The decline in freight transportation came to an end in 1995. Since that time the tendencies of increase took start.

The further restructuring of the transport sector in Lithuania is mostly based on the creation of favourable legal and institutional framework for the transportation business. At present the Lithuanian hauliers are ready to operate in the conditions of free competition by abandoning the system of quota for international carriages. The road maintenance and construction companies develop their activities successfully by implementing modem technologies. The stevedoring companies of the Klaipeda Port and other maritime transport enterprises provide high quality of the services.

From this point of view the railway transport experiences the widest range of problems. For that reason its restructuring is the important objective to be achieved in the nearest future. It is foreseen to provide other operators with the possibility to use the network, by identifying the economically viable principles of infrastructure charging and financing, and by renouncing the inefficient mechanism of cross subsidising.

The improvement of the public passenger transport management by ensuring equal conditions for private and municipal carriers will deserve a significant attention.

Concluding Comments. It is of vital importance and in line with the Common Transport Policy to establish the Institutional and Policy framework conditions for the required efficiency and competitiveness of the overall European Transport sector. As under the conditions of Transition economies we harmonise our laws and regulations and try to adopt the Western ideas, we recognise that the Transition economies are, in many ways, similar to laboratories for developing and implementing of new, untried concepts and systems. We are in a position no one has been in before. This is most evident in our harmonisation and privatisation programmes, which underpin the development of various institutions.

8. Lithuanian transport in the context of negotiations on the EU membership

Process of Transport sector integration into the EU. Activities of Lithuanian transport sector have a clearly defined international character, because the national production and consumer market is not sufficient for complete and effective use of the existing transport system potential for satisfaction of requirements of the interior economy demands. Maritime transport, civil aviation operates actually exceptionally in the international market. 83% of freight handled by the railways fall to the export-import and transport services market. Road transport operation increases rapidly (in 2001 Lithuanian carriers transported almost 15 million tons freight by international routes, i.e. 50% more than in 1997).

Acceleration of economic integration processes will doubtlessly precondition the increasing future demand for transportation, particularly with the view of the fact that Lithuanian economy is intensely preparing for operation in the united market of the EU countries. Elimination of borders in the enlarged EU will induce the bartering by gradual shifting from the storage-oriented economy to the flow-oriented economy with distribution of goods to proper destinations in proper time. Therefore transport may be treated as one of the most important branches of the European economy and the necessity to form the common European transport policy (including the accessing countries) in the context of European integration is of a particular importance. In this aspect it is evident that Lithuanian transport enterprises will have to withstand a great competitive pressure of the common market since they will have to operate observing the equal legal and administrative requirements and standards of the EU.

At present Lithuanian transport sector is undergoing intense preparation for the EU membership. The experience gained during the EU negotiations allows definition of preliminarily certain results expected in regard of the economic and social situation in Lithuania.

Primarily, it has been agreed on the three transition periods in the following fields:

- on application of financial standing for licensing the activities of local road transportation – until 2007;

- on use of tachographs – until 2006 – (the equipment for registration of drivers' work-rest regime) to be installed on the road transport means destined for local transportation, produced until 1987;
- on noise restriction, in Kaunas airport, caused by aircraft of the third countries – until 2005.

For grounding\substantiation of the necessity of the transit periods as well as at the meeting of numerous remarks and comments of experts of the European Commission an adequate information is being prepared and submitted with the aim of comprehensive setting of plans and progress of harmonisation of legal acts and improvement of administrative structures, as well as taking new obligations for the implementation of the regulations and directives adopted already in the course of the negotiations.

In the administrative institutions and in businessmen circles it is vastly discussed about possible advantages and losses of the EU membership, which may be exercised on Lithuanian transport sector. Also the impact of requested transition periods on the market integration process is also the object of discussions.

In the process of negotiations it appeared that the European Commission and the member states are not inclined to relate the requested transition periods designated exceptionally for the internal market with the possible restrictions of the international transportation market access. At present it is possible to maintain that Lithuanian negotiators succeeded in proving that the delays of implementation of certain directives are sufficiently limited in the aspects of time and operation field, therefore essential distortions of competency are not likely to be caused. It means that the EU member states are ready to give the Lithuanian carriers the market access without any travel authorisations for the international transportation quotation since the first day of Lithuania's membership in the EU. The transitional period, proposed by the EU member states, on cabotage transportation restriction in their territories, may be viewed as less "evil" since the cabotage market is not so attractive, if compared with the international market in which Lithuanian companies have already now quite a strong position.

It should be noticed that for the negotiation partners in principle there is acceptable also the transitional period on the flight to Kaunas airport possibilities for the aircraft exceeding the EU noise standards, as the prolongation of this environmental safety requirement for one year will not cause a significant superiority with regard to the airports of neighbouring countries.

The acceptability of the Lithuanian position to the EU member states means that in the nearest future, for the time being, there will be no necessity to extend negotiations on the Transport policy chapter, also including the fields in which the transitional period is required. However, the EU is not going to diminish its attention towards our further integration process of implementation of legal and administrative EU requirements. Particular attention will be focused on the acceleration of railways restructuring and improvement of maritime shipping safety (according to the recently adopted packages of directives).

It will be necessary to adapt not only the present Transport *Acquis* standards, but also to implement constantly the newly approved EU requirements. The growth of such requirements may be foreseen, as the European Commission quite recently (in August 2001) has approved the White Book "European transport policy for 2010: time to decide". The title of this document itself demonstrates that the present situation in transport does not sufficiently reflect the needs of the common EU market, therefore it is necessary to co-ordinate efficiently the further implementation of the strategic provisions of the sector development.

Considering the Lithuanian transport sector development strategy in the context of the White Book, it should be stressed that in the Government programme for the years 2002–2004 the priorities are given to such issues as: the incentives of intermodal transport, railway restructuring and the service market liberalisation, traffic safety, technical harmonisation and assess, improvement of public transport services. It means that prioritised are the same fields that are given priority in the new European transport policy. However, aiming at the development of the sustainable transport system, the European Commission proposes a wide range of new initiatives and measures, the implementation of which will require correction of strategic documentation and legal regulations, naturally, with regard to the particularities of Lithuanian transport system.

9. Impact Assessment of the Railway Infrastructure Package (Directives 2001/12/EC, 2001/13/EC, 2001/14/EC, 2001/16/EC)

In 2001, the Lithuanian National assessment programme of social economic impact of Pre-accession was prepared. The authors of the article performed the impact assessment of the EU railway infrastructure package (directives 2001/12/EC, 2001/13/EC, 2001/14/EC and 2001/16/EC). The results of this analysis are presented below.

Implementation of the Directive 2001/12/EC in Lithuania. At present the Railway transport operation is regulated by the Railway Transport Code of the Republic of Lithuania, which was prepared basing on the provisions of the Directive 91/440/EEC. The Railway Transport Code defines the principles of Lithuanian railway activities: accessibility of public railways for all railway operators, fair competition with other transport sectors, independence of railway enterprises.

By the Governmental Resolution No 997 of 22 08 1996 the SPJSC "Lithuanian Railways" was designated the infrastructure manager, legally supervising public railways and providing related services to the railway enterprises.

By the Governmental Resolution No 559 of 15 May 2001 on Lithuanian railway sector reform and main directions, the provisions providing legal, economic conditions for commercial operation of the railway transport enterprises were approved. The aim of this document is to ensure the formation of a competitive, corresponding to the EU requirements, Lithuanian railway transport sector. In principle the provisions of this Resolution are in line with the requirements of the new infrastructure package.

On 8 May 2001, the Seimas (Parliament) of the Republic of Lithuania adopted the law by which the company "*Lithuanian Railways*" is no longer obliged to possess the special purpose status, and since 29 June 2001, after the registration of new regulations the "*Lithuanian Railways*" became a stock company.

For the implementation of the requirements of the Directives 91/440/EEC and 2001/12/EC it is necessary to prepare and to adopt the following legal acts:

1. Regarding the regulation of non-discriminate access to the railway infrastructure there is to be prepared Governmental Resolution or Order of the Minister of Transport and Communications by which the functions of the State Railway Inspectorate should be extended.

2. With the aim of ensuring the independence of railway enterprises' operation and meeting the public service obligations, the Railway Transport Code has to be reviewed. It should be provided for the clear separation of State and railway functions, as well as a total

reimbursement for performance of public service obligations and liability in case of malfunction either of Contractor or of service provider.

Acting in accordance with the implementation plan of provisions and main directions of Lithuanian railway sector reform which was approved by the Resolution of the Lithuanian Government Meeting of 2 May 2001 (Minutes No 21, item 23) also acting in accordance with the Governmental Resolution No 559 of 15 May 2001, On Lithuanian railway sector reform and main directions in 2002, there shall be established three subsidiaries of the *JSC* "*Lithuanian Railways*" in accordance with the variety of their activities. They will be as follows: *JSC* "*Passenger transportation services*", *JSC* "*Cargo haulage services*" and *JSC* "*Railway infrastructure*".

Implementation of the Directive 2001/13/EC in Lithuania. At present the provisions of the Directive 95/18/EC are partly implemented in the Railway Transport Code, as well as in the Governmental Resolution No 406 of 29 March 1996 (amendments in Decision No 295 of 09 March 1998) and in the Order No 20 of the Minister of Transport and Communications as of 20 01 1998. Acting in accordance with these legal acts, 5 licenses for passenger and freight haulage were given to operators. Nevertheless, the above mentioned legal acts are not sufficient enough for the implementation of the EU requirements. Their main shortcoming is that there are not foreseen: measures necessary for the ensuring of traffic safety, license bearer's responsibility for the damage caused by an accident, the financial standing requirements, etc.

For the implementation of the provisions of the Directives 2001/13/EC and 95/18/EC there should be reviewed the railway enterprises licensing rules, approved on 20 January 1998 by the Order No 20 of the Minister of Transport and Communications and supplementary provisions should be made as follows:

- good repute and financial standing,
- management and staff professional competence,
- meeting technical requirements for railway operation,
- compliance of safety requirements for staff and technical means (rolling stock),
- medical requirements for staff fitness.

Concerning the requirements of the Directive 2001/14/EC in this field it would be purposeful to foresee in the legislation that an enterprise (which has already received a license) is not allowed to start its activities unless it is not rated in line with the safety requirements, i.e. until it receives safety certificate.

Implementation of the Directive 2001/14/EC in Lithuania. At present the main provision of the Directive 95/19/EC requiring the ensuring of the right for access of all operators to the Lithuanian railway infrastructure has been partly implemented in the Railway Transport Code of the Republic of Lithuania. However, the procedure of allocation of railway infrastructure itself has not been considered in any of the legal acts of the Republic of Lithuania.

By the Order No 8.1 of the Minister of Transport and Communications as of 10 August 1998 there were defined temporary charges for infrastructure use. This applies to all operators irrespective of their subordination.

By the Governmental Resolution No 319 of 10 May 1993, the State Railway Inspectorate was established. It takes care of railway transport safety.

At present there has been developed the Draft Law Amendment of Articles 3, 7, 20, 22 of the Railway Transport Code and the Code supplement by Articles 6(1), 6(2). With the support of

the Phare project "Legal Harmonisation in Transport. Phase III" there were supplied proposals for the Rolling stock certification procedure, Safety certification – after adoption of which the provisions of the Directive would be fully transposed into the National law.

For the implementation of provisions of the Directive 2001/14/EC in Lithuania it is necessary:

1) to prepare the Lithuanian network statement;

2) to prepare calculation methods of charges for infrastructure use and on this ground to define the system of infrastructure charging;

3) to establish a relevant Regulatory body;

4) to prepare safety certification rules;

5) to appoint an authority responsible for issuing safety certificates and implementation control.

Results expected after the implementation of the provisions of the Council Directive 2001/14/EC:

6) transparent and non-discriminate access to railway infrastructure, which in turn will induce competition of railway enterprises and will stimulate the development as well as the quality of railway services;

7) better efficiency of freight transportation will be achieved after introduction of the unified licensing procedure for railway enterprises, the licences being recognised in the whole Community, thus opening markets of separate states;

8) fair intermodal competition of railway and road transport and decrease of competition distortions between various transport modes;

9) fair and non-discriminate satisfaction of all the needs of railway infrastructure users;

10) optimisation of railway infrastructure usage;

11) decreasing of cases of disorder in railway infrastructure usage, improvement of network operation quality;

12) fair competition of railway services;

13) efficient management of railway infrastructure and reduction of infrastructure management expenditure;

14) establishment of an independent regulatory body to supervise that railway enterprises meet the requirements of the regulations.

Implementation of the Directive 2001/16/EC in Lithuania. For the time being the requirements of this Directive are not yet transposed into the National law because the Directive basically regulates absolutely new field for the Lithuanian railways.

For the implementation of the Directive 2001/16/EC it is necessary:

1) to review the Railway Transport Code;

2) to develop the procedure of ensuring that the railway transport infrastructure and rolling stock investment projects meet the requirements of the TSIs;

3) to appoint a Notifying body responsible for notification of TSIs;

4) to define type approval procedures in regard of correspondence and fitness of component parts for usage;

5) to establish and keep the register of infrastructure and rolling stock (after reviewing the Order No 343 of the Minister of Transport and Communications);

6) to establish a Working Group on the preparation of TSI structural sub-systems projects of the national railway system;

7) to take part in the meetings of joint representatives working with TSI projects.

In regard of compatibility of technical systems there should be singled out three main types of railway compatibility:

- compatibility of railway systems having uniform track gauge (1435), but with different signalling, electric power supply and traction rolling stock types;
- compatibility of systems having different track gauges;
- compatibility in all aspects not related with the railway track gauge.

As earlier such works were not carried out, their volumes are not clear, thus it is difficult to judge how long such work may last.

It should be noticed that for the implementation of the measures mentioned above substantial financial resources will be necessary (for the implementation of the projects for substitution of signalling system, rehabilitation of traction rolling stock fleet, etc.).

Impact upon JSC "*Lithuanian Railways*". It is expected that the implementation of the new package of the Directives will bring significant results to the Lithuanian railways, first of all in the restructuring of the railway enterprise into separate units, dividing passenger and freight transportation and the management of the infrastructure.

The aim of the railway transport reform, the main policies and directions of which have been approved by the Governmental Resolution No 559 of 15 May 2001, is the reorganisation of railway transport market by the following means:

- transfer of link roads to the economy subjects;
- closure, conservation or demolition of the loss-making railway sections;
- selection by tendering of operators for passenger transportation on separate routes;
- detachment\separation of auxiliary activities, as well as the activities that are not characteristic of railway and establishment of JSC to perform these activities;
- to reorganise essentially the Lithuanian railway management structure.

JSC "*Lithuanian Railways*" is the largest service providing enterprise in Lithuania. According to the Statistical Department data of 2000, the railway transport accounts for 40.3% of the total amount of freight and for 2.3% of passengers carried by all modes of transport.

Annual turnover of the company makes about LTL 620 million yearly, more than 80% of which account for freight transportation. The staff of the company reaches 15 600 people.

Technical condition of the sector at present is not satisfactory. Repairs of 534 km road are delayed, 22% of tracks are worn out, signalling equipment has been operating 25 years in average, maximum operation time being 30 years, locomotives have been operated 21 years in average, normative operation time of locomotives being 25–30 years, freight wagons usually are exploited 19 years, normative wagon operation time being 20–25 years.

In 2000 the excise of the company for the used fuel reached LTL 41.1 million, half of which being transferred to the Road Fund. The company pays LTL 3.2 million road charges yearly. Every year in average about LTL 180 million charges are paid into the State budget.

Opportunities and alternatives of solving the cross-financing problem. At present, when there are no separate accounts for passenger transportation, for freight transportation and for infrastructure management, and when these functions are carried out by the *JSC* "*Lithuanian Railways*", the Company can not refuse cross-financing for passenger transportation because it

would mean first of all the bankruptcy of the passenger unit (i.e. bankruptcy of a part of the Company). Cross-financing is inevitable when the state and municipalities are not able to cover totally the losses of performing public service obligations (passenger transportation).

Aiming at the reduction and afterwards at the full refusal of the cross-financing, the *JSC* "*Lithuanian Railways*" at present carries out the following policy (6):

- reduces the number of passenger routes;
- reduces the costs of passenger transportation (coupled routes, reduced length of routes, simplified train service technology, etc.).

JSC "*Lithuanian Railways*" is also preparing proposals to the Ministry of Transport and Communications and to municipalities concerning envisaged routes of passenger trains through the territories of municipalities, prices of the routes, necessary reimbursement for losses and inadequacy of costs.

Cross-financing may be reduced gradually, i.e. when the state and municipality every year increase reimbursement for covering all expenditure related to passenger transportation. At the same time there has to be carried out the audit of passenger transport services provided by agreements or substituted by alternative transport means. As it has been mentioned, at present the amount of LTL 95 million is necessary for yearly compensations of public service obligations. After implementation of the means of the unprofitability reduction the actual amount of such payments should reach about LTL 60 million.

Railway infrastructure finance resources, need for means, alignment of legal basis with the EU requirements. During the implementation of the National Transport System Development Programme and of National Investment Programme, until 1 January 2001, the Company has taken in the name of the State the loans for the total sum of LTL 262.1 million, and the sum of received loans with the interest and fine for the same time made LTL 414.3 million.

According to the EU Directives the financing sources of the railway infrastructure are following:

- maintenance and operation financed from the infrastructure usage charges (at present an average need of these means is LTL 150–170 million);
- the State aid is provided for the reduction of the railway debt.

Renovation and development of infrastructure is financed by the investments of the infrastructure owner. Thus, taking into account the fact that the State itself is the infrastructure owner, the investments allocated by it are not even considered as the State aid.

Taking into account the present state of Lithuanian railway infrastructure, as well as the strategy of implementation of the TINA Programme until 2015, the yearly requirement of investment reaches about LTL 280–300 million, and about half of the sum (LTL 150 million) should be allocated from the State budget.

According to the prepared development programme of the *JSC* "*Lithuanian Railways*" the sources of investment for 2002–2007 should be as follows:

- financing\subsidies received from the EU funds (ISPA);
- loans from international finance institutions;
- Company means (amortisation deductions);
- the fund for financing the railway infrastructure renovation and development programme (State budget);

- the means received by attracting the progressive principles of private and public (state owned and that of municipalities) capital partnership.

The system of infrastructure users charges, the level of these charges and their impact on the activities of operators. The infrastructure users charges have to cover the routine maintenance and operation costs. Their basic quantities have to be uniform to all the users of the railway infrastructure. At present in the Western Europe the charges for the infrastructure vary from EUR 0.5 for a train kilometre in Netherlands to EUR 7.5 in the United Kingdom. In Sweden these charges make 0.7; in Austria – 1.5; in France – 2; in Italy – 2.5; in Germany – 3.2; in Switzerland – EUR 3.5 for 1 train kilometre.

For the determination of the size and the mechanism of levying the infrastructure users charges it is necessary to consider the actual railway infrastructure expenditure of maintenance managers, as well as to the principles of levying railway charges and the exceptions of levying, determined by the Directive (2001/14/EC), and also the defined possible concessions for users of the railway infrastructure and possible expenditure related with the compensations for not covered costs of environmental safety, and costs for elimination of consequences caused by incidents.

In the case of the present situation, when the *JSC* "*Lithuanian Railways*" compensates the biggest part of losses of passenger transportation, finances the investment programme of rehabilitation of the railway infrastructure and development, and at the same time the Company is compelled to pay back the loans taken for the rehabilitation of the railway infrastructure, certain additional expenditure should be included into the infrastructure charges.

Aiming at environmentally friendly and under certain conditions cost effective railway transport, the State may subsidise a part of general expenditure of railway infrastructure, thus facilitating the activities of operators (such state approach exists in Sweden, Norway and other countries).

However, the Directive 2001/14/EC also provides for a particular case – it is for "congested infrastructure", which means a sector of infrastructure for which demand for infrastructure capacity can not be fully satisfied during certain periods even after co-ordination of the different requests for capacity. In this case for the capacity enhancement there are foreseen increased infrastructure charges (for the implementation of specific development projects).

Impact on new railway operators. The implementing requirements of the new railway infrastructure package each enterprise will have to ensure and to meet three main requirements necessary for license acquisition:

- financial standing;
- good repute and
- professional competence.

An enterprise seeking a license will have to ensure the possession of traction means. In addition the enterprise willing to transport goods shall have to receive a safety certificate for each route on which transportation operations are planned. Nevertheless, by getting a license for goods and/or goods transportation by the railway transport there are more possibilities for operational activities in the whole territory of the Community.

The main conclusions of the impact assessment:

1. In summary of the results of the above calculations we may conclude that the direct qualitative profit caused by restructuring of Lithuanian railways according to the requirements

of the new package of the EU Directives (considering that the railway restructuring will be fully finished by 2005) would reach LTL 215 million yearly, while the cost of implementation of the package of new Directives would make yearly about 0.5 million more.

2. It must be emphasised that the present results of a rather general calculation by far do not reflect all main aspects of commercial operation of the railway reorganisation. The efficiency of the railway activities, with respect to other transport modes, comes out with the economy of external transport costs that are paid by public. For calculation of the benefit it is necessary to make a detailed additional analysis of present and forecasted external transport costs in Lithuania. The analysis will enable more precise quantitative evaluation of the benefits of railway activities concerning the inhabitants of the whole country.

3. The adoption of the EU *Acquis* on railways is related with the direct EU support for modernisation of the railway infrastructure with the help of the opportunities given by the financial instrument of ISPA.

4. The consequences of the implementation of the new directives are expected to make an impact on administrative structures, as certain additional functions will be attributed to relevant institutions, as well as the growth of administrative capacity of the state is expected and the essential restructuring of the *JSC* "*Lithuanian Railways*".

5. There is expected a substantial impact on the State budget as well: bearing in mind that the principle of cross-financing will be not applied and because of the need to ensure the approximation of the technical level of the railway infrastructure to the EU standards, LTL 210 million will have to be allocated from the budgetary assignment.

6. It should be remembered that the EU legislation regulating railway activities in future will be also improved and developed: already in the year 2002 it is expected to adopt the second package of the Directives which will propose the liberalisation of all the activities of transportation of goods, including cabotage. Therefore, the restructuring of the Lithuanian railways will not be a short-term process, because in the future this sector inevitably will encounter the needs of modernisation, commercialisation and restructuring. The latter statement can be proved by the fact that in the recent White Paper on European transport policy there are defined quite ambitious goals for the period up to the year 2010: significant increase of goods transportation market share\rate, essential ensuring of the technical compatibility of national networks, reaching the average rate of delivery of goods in Europe even to 80 km per hour (at present it reaches about 20 km/h), integrated passenger transportation services, including full information, booking and ticketing "on line" for all business and holiday trips, etc.

References

1. Baublys A. Transport: background, future, studies and science // Lithuanian science (Lietuvos mokslas) – 1996. – T. 4, book 10. – p. 82–103;
2. National Transport Development Programme of the Republic of Lithuania. Ministry of Transport of Lithuania. – Vilnius, 1993. – p. 141;
3. Jarzembowski G. The European Transport Policy. –Brussels, 1998. – p. 74;
4. Transport infrastructure needs assessment in Central and Eastern Europe. EC (DGIA, DGVII). TINA SECRETARIAT.– VIENNA, 1998. – p. 81;

MODELLING OF NATIONAL MULTIMODAL TRANSPORT NETWORK

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It is realized long time ago, that one of the main factors for country steady grooving economic is a properly working transport system, in which not last place takes a mean of cargo transportation, so-called multimodal transport. But like all other means of transport it experiences problems related to the development and optimization of proper infrastructure (network of roads and terminals).

In the article there is made an attempt to simulate a national multimodal transport network.

The basis for such model lies in the investigation of freight flows, during which we identify the possible routs for freight transportation (as well as places where such freight is shifted from one mode of transport to another), extend the existing statistic database on modal transport carriages and start to develop a new database on multimodal freight carriages. With the help of the last one, we can start to create the model of national multimodal transport network.

1. Introduction

In recent decades, the transportation of goods has been growing in Europe, thus making the efficient freight transportation system a major component of highly developed national economy. In this respect, the efficiency of multimodal transportation is often mentioned. Multimodal transportation is usually referred to as a transportation of a particular cargo by different transport facilities without transfer. In Lithuania, this type of transportation could be associated with the transporting of goods by combining railroad – road, road – sea and railroad – sea transport as well as the networks of respective modal infrastructures and cargo transfer terminals.

The novel types of transport facilities, freight containers and their handling technologies widely extend the potentialities of multimodal transportation, thus making the multimodal network modeling a basic element of further development in this area.

A major goal of this paper is to provide one of the possible variants of developing national multimodal freight transport network.

2. Investigation of Freight Flows

The network considered should embrace the modal freight transportation infrastructure from the origin and destination points (having some indices) in Lithuania and abroad. For this purpose, freight flows should be investigated, in order to establish how many operators and in what way use the multimodal transportation in the country and for exporting goods. A survey would require the data from operators on :

a) the points of origin and destination of the trip ;
b) the types of goods transported, their tonnage and value ;
c) the sequence of using various transport facilities.

The results of the research would make the basis for freight transportation map plotting, showing the routes of multimodal transportation and the places of transport facilities changing. To achieve this, a computer – aided program for the research data processing and presentation in the form available for the user should be developed. However, this is not the issue discussed in the present paper. The problem of developing the national multimodal transportation network showing the routes in compliance with those obtained in the reports on freight flows investigation is considered. The relevance of freight flows research is primarily for storing the data on multimodal freight transportation between the origin and destination points. It is important, because the data at the disposal of the authorities are based only on the transportation performed by modal transport facilities between departure and destination points. This means that the geography and multimodality of freight transportation are not taken into account. The study of freight flows would fill the gap, as well as providing the information about the modal freight transportation. Therefore, the research considered could provide the basis for solving the problems of developing and presenting the multimodal freight transportation network as follows:

a) development of multimodal network by investigating various modal networks ;

b) finding the terminals closest to the origin and destination points, allowing the multimodal network optimization ;

c) assessing terminal operation in the context of the whole network, in order to obtain most adequate view of the multimodal freight transportation network.

3. The Development of Multimodal Transportation Network

The development of a general network would include the integration of the separate modal networks into a unified system, ensuring the multimodal transportation between any two network points denoted by certain indices. Thus, an integral network will be developed allowing any combination of modal routes sequences. All the links of the network represent actual roads at certain geographical location specified in freight flows investigation reports. A general network will be created by connecting the networks of particular transport facilities via a number of road – railroad (RR), road – waterway (RW), and railroad – waterway (RRW) transport terminals. This concept is illustrated in Fig. 1 for the interaction of road and railroad transport networks.

The network development proceeds with connecting the first road transport network and the network of railroad transport via the first RR terminal, and then back to the second road transport network through the second RR terminal.

The use of the required transport facilities at a particular stage of transportation will be provided in the following way. At the beginning, all the components of the general network are “turned off”. It is assumed that any transport facility is used in its turn, at the moment required. Then the first part of the general network is “activated”, which is 1 – st road transport network with RR terminal closest to the starting point denoted by a particular index. In a similar way, the terminal for getting to 2 – nd road transportation network is found. The part of the route for railroad transportation is inserted between the first and the last road transport networks via the corresponding RR terminals. Thus, the terminals located along a particular route close to particular indexed departure and destination points ensure the proper sequence of using the available transport facilities.

By the way, in cargo transfer at the terminals, some additional entrance/ exit links, not belonging to any of the modal networks but forming a general network, should be taken into account. This is shown in Fig. 1 and will be discussed in the following chapters.

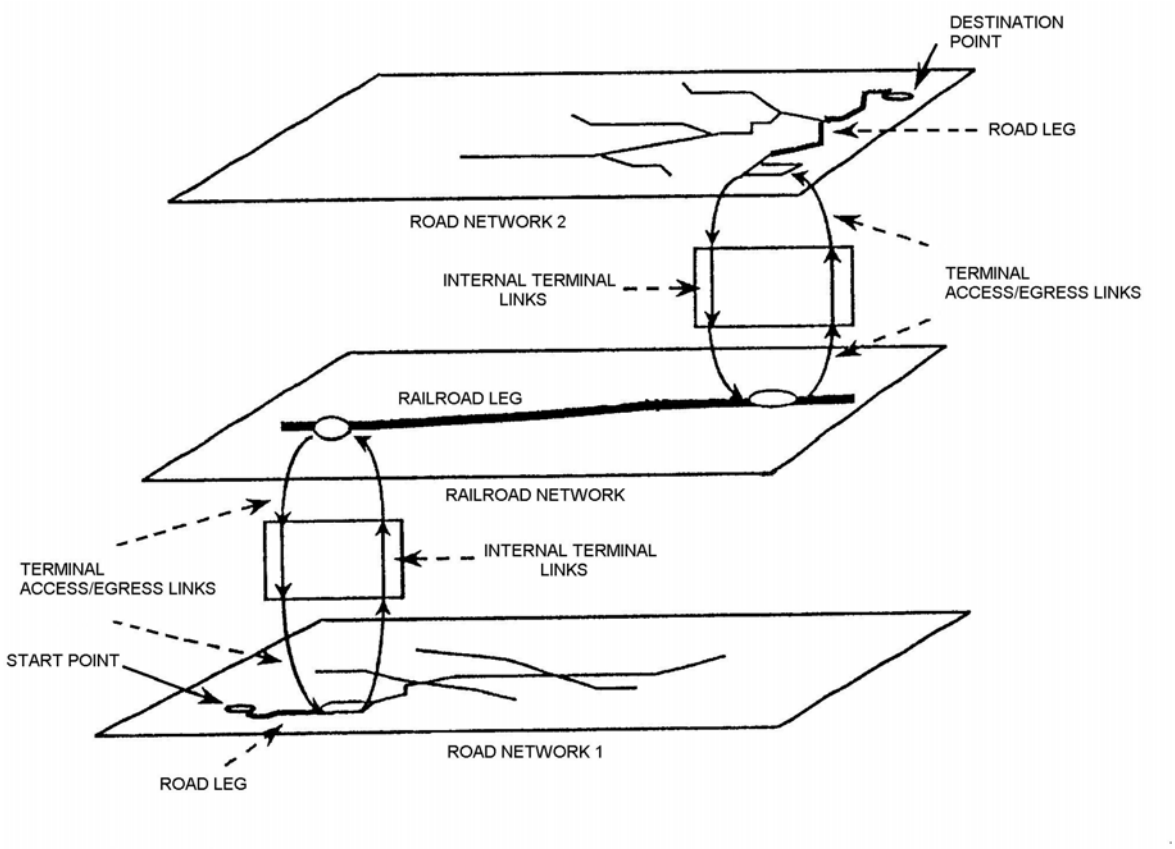

Fig. 1 Integration of the particular modal networks into a general multimodal network

For now, it can be stated that when individual modal networks and terminals connecting them, which have their own entrance/exit links with a particular modal network, have been taken into consideration, we obtain a general geographical view of multimodal network.

The problems which may arise with respect to the above visual network presentation are as follows :

a) a large number of links may appear to be of zero – length, since they represent a process taking place at a point (i.e. cargo transfer at a terminal),

b) some objects may overlap (i.e. terminals for freight handling located at the same geographical area).

To avoid these problems, a possibility should be provided in developing a network to slightly alter the location of the points in such a way as to avoid placing two objects in the same geographical area. This could provide a certain length for the link as well as avoiding overlapping of the objects.

4. Determining the terminals nearest to starting and destination points in transportation

In order to begin working out the routes for freight transportation, every individual modal network should be slightly modified to be integrated into a general network. In addition, the inclusion of such specific links as railroad access tracks and approaches to terminals, the information of which is not provided anywhere, requires some modification. The networks of particular transport facilities should be modified in the following way:

1. In representing road transport networks, the corresponding road transport terminals, acting as the ways of intermediate stops in the route, should be taken into account. The approaches to such terminals should be handled as some additional links in a network.

2. Water transport network should be divided into two smaller, but closely related subsets. They are the network of the inland water transport and sea transport, in which different types of ships are used. It is important to identify the locations of cargo transfer from the ships of various types, adding special links to a general network in these places.

3. In railroad transport, the fact that various railroad operators can operate on particular railroad lines should be taken into account. This is important, because the operators transporting cargoes to various countries greatly extend the geographical database of transportation as well as increasing the number of additional links.

In addition, railroad and road transport networks should be extended to embrace major roads of the neighbouring countries by connecting them to Lithuanian internal transportation networks. This should be achieved by adding new links at the points of crossing the border.

Having made the appropriate modifications, a rather accurate view of an multimodal transportation network would be obtained. However, to make it optimal, one or more terminals nearest to a departure or destination points of the route, provided with the particular indices, should be determined. For this purpose, a formula is used to find a radius, at the range of which with respect to the indexed departure point of the trip the required area could be found, with the terminals on it to be used as entrance/exit points to/from the multimodal network:

$$R_{\max} = R_z + (2e) + p\,; \qquad (1)$$

here,

R_{max} – radius of searching for the network entrance/exit points (terminals);
Rz – the shortest distance from the point having a particular index to an arc of a circle described by a search radius;
e – the least root – mean – square error in determining the location;
p – maximum length of entrance/exit links to/from the network, not entered into modal infrastructure data base of a particular transport facility.

It should be noted, that ***e*** and ***p*** values for the particular transport facilities should be obtained experimentally.

By applying the formula (1), maximum search radius from an indexed departure or destination point of the trip could be found for any transport facility, with all the terminals in the range of this radius being the potential entrance/exit points to/from the multimodal network. How it works, is shown in the Fig. 2. But once again it should be noted, that the search for the terminal varies slightly, depending on the type of transport facility.

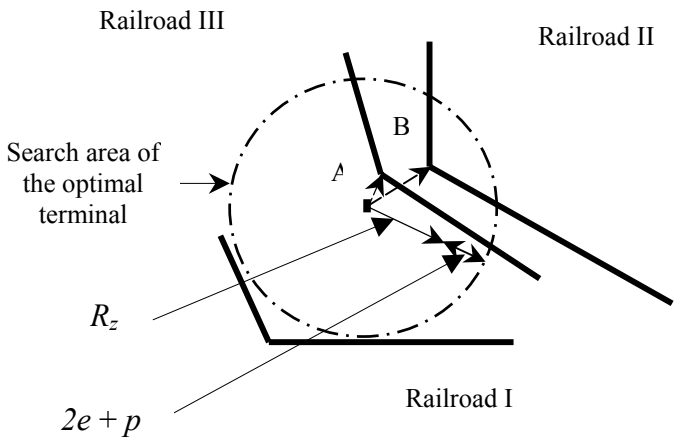

Fig. 2. The search for the optimal terminal in transport network

5. Assessment of terminal operations in detailed presentation of multimodal network

In section 3 it was mentioned that, developing an multimodal network out of individual modal networks, the areas for linking the above network where cargo transfer would take place should be provided. To obtain more detailed view of the network, a terminal should be presented (and assessed) as a separate link. In Fig. 3, two possible variants of terminal presentation and evaluation in a general network are given.

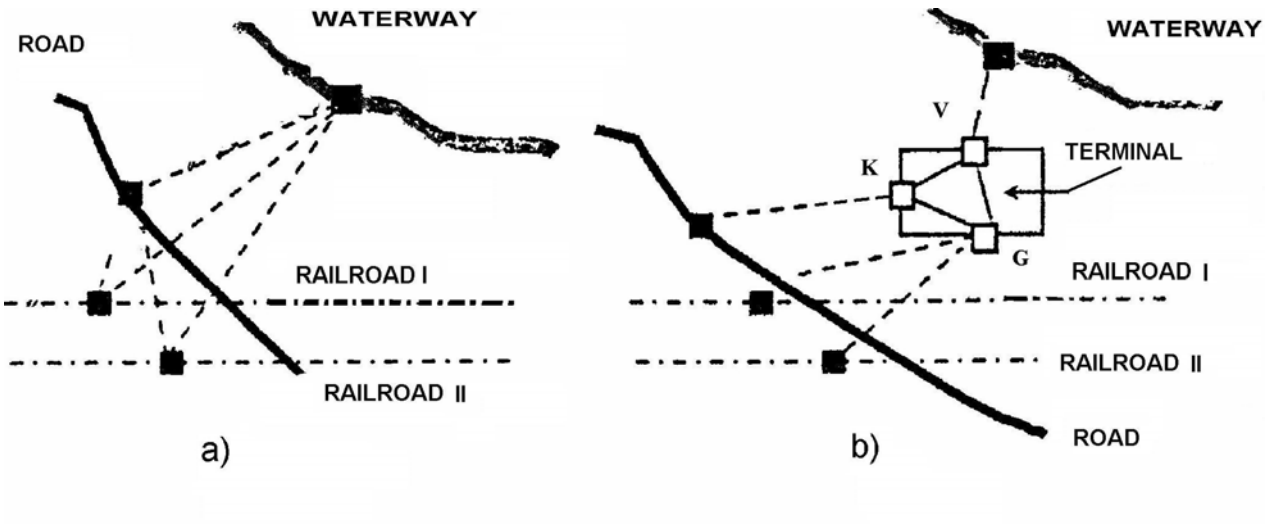

Fig. 3. Two ways available for terminal operation modeling

One of them (Fig. 3a) may be referred to as a bimodal link method, because each cargo transfer operation is represented as the only additional link between two different transport facilities (they are shown by a dotted line in the picture). This would be the easiest solution, allowing a number of links of a particular direction to be related to a separate modal network of transport facility.

Another approach to considering and representing terminal operations is shown in Fig. 3b. In this case, a transport terminal located in a certain geographical area is considered together with the actual entrance/exit links to/from the corresponding modal network (they are shown by single dotted – lines leading to the entrance gate of the terminal, denoting V – water, K – road, and G – railroad transport, respectively). It should be noted, that for the 1 – st type of transport more than one entrance gate may exist. This more complex variant is particularly effective for the situation when modal networks are rather rare, requiring sufficiently long entrance links to integrate the terminals into a general network. It is also important in areas, where the gates face various directions.

6. Conclusions

1. One of the available models of developing national multimodal freight transportation network has been considered. It is based on the analysis of freight flows, providing the initial

data for model development. Currently available statistical data on modal freight transportation has been extended and some data for a new database on multimodal freight flows have been stored.

2. Based on the data of the present research, a model of Lithuania multimodal freight transportation network may be developed and applied to practical needs.

3. Due to universal character of the data collected and the use of simple algorithms, modeling may be performed in three stages aimed:

- to develop an intermodal network by connecting individual modal networks into an integral system ;
- to optimise the network, identifying optimal freight handling terminals for any origin or destination point of the trip mentioned in freight flows survey ;
- to evaluate the processes taking place in the terminal, thereby optimising the operations performed as well as presenting most adequate and detailed view of the multimodal network.

References

1. J. Guelat, M. Florian, T. G. Crainic. A multimode multiproduct network assignment model for strategic planning of freight flows. Transportation Science, No 24, 1990, pp. 25-39.
2. M. Florian. An introduction to network models used in transport planning. In “Transport Planning Models”. Amsterdam: North-Holland. 1984, pp. 137-152.
3. M.S. Bronzini. Evolution of multimodal freight transportation network model. Transport Research Forum, 21st annual meeting. 1980.
4. A. Baublys. Introduction to the theory of transport system. Vilnius: Technika. 1997. 298 p. (Lithuanian).
5. F. Southworth, B.E. Peterson. Intermodal and international freight network modeling // Transportation Research Part C, No 8, 2000, pp. 147-166

ANALYSIS OF THE TRANSPORT FLOWS SERVICE TIME OF THE VEHICLES AND ASSESSMENTING OF THE IDETERMINANCY OF EXTERNAL IMPACT

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Basing on the assessment of formulation of the objectives of management of transport flows and on the indeterminacy of external impacts, it is possible to carry out a more detailed analysis of the distributions (according to time) of flows of transport means entering customs, as well as their distribution in to separate customs lanes. It also enables the definition of dependency on the extent of transport flow, as well as allows the calculation of choosing optimum transport amount for the inspection in customs-houses during a certain period of time.

1. Introduction

With the aim to increase the attraction of Lithuania as a transit country it is necessary to identify the main obstacles in the field of border crossing and formalities of customs procedures.

While analysing this situation it is important to explore the incoming and outgoing transit transport flows, to identify their theoretical distribution in proportion to customs and transport pressure on customs as well, to formulate the objectives of management of transport flows and to assess the indeterminacy of external impacts.

Basing on the formulation of estimation of service time for vehicles and on the assessment of indeterminacy of external impacts it will be possible to perform detailed research of flow distribution of incoming transport means according to the time and their distribution in separate customs lanes [1–3]. It will also allow to identify the idle time of transport means and to measure the dependence of carriers' service time in proportion to transport flow.

2. Estimation of service time of vehicles

Basing on experiment, we see that flows of cars entering a customs post is distributed to identify the exponential law. Thus at every moment the average quantity of cars in to platform $\overline{n}$ it would be formulate by average speed of arriving cars by average service time and dispersion of service time:

$$\overline{n} = \frac{\lambda}{\mu} + \frac{\lambda^2 \sigma_{t_s}^2 + (\lambda/\mu)^2}{2\left[1-(\lambda/\mu)\right]}, \tag{1}$$

there $\sigma_{t_s}^2$ – dispersion of t_s service time. From (1) equation it is that if are senses λ and μ fixed, the average quantity of arriving cars increase by increasing dispersion $\sigma_{t_s}^2$. If λ and μ

are invariable, the average quantity of cars in the platform is according $\sigma_{t_s}^2 = 0$. When the speed λ of arriving cars and service time μ is the same, then:

$$\overline{n} = \frac{\lambda}{\mu} + \frac{(\lambda/\mu)^2}{2\left[1-(\lambda/\mu)\right]}. \tag{2}$$

If service time of arriving cars is distributed along exponential law and if it have negatively sense and average sense μ, then $\sigma_{t_s}^2 = 1/\mu^2$. In this case the equation (1) will be:

$$\overline{n} = \frac{\lambda/\mu}{1-\lambda/\mu},$$

From (1) equation we see, that average quantity of cars are increased when the average quantity service time $(\lambda - \mu)$ existing.

From this equation we see, that along establishing distributing law of service time of cars in the platform would be decreased only decreasing quantity λ/μ. The proportion to decide average quantity of cars in platform. For example if decrease λ/μ quantity $1-(\lambda/\mu)$ increase, but quantity of cars in the platform is decrease [4–6].

3. Assessment of the inderminancy of external impact

Let us analyse the objective of the optimal management of transport flows (3)–(7).

$$J_0(X,\ U,\ t) \to \max; \tag{3}$$

$$\Delta X(t) = \varphi(U,\ t),\ \ t = \overline{0, T-2}\ ; \tag{4}$$

$$l(t,\ \xi) \le U(t) \le f(t,\ \xi),\ \ t = \overline{0, T-1}\ ; \tag{5}$$

$$X(T) \le g(t,\ \xi),\ \ t = \overline{1,\ T}\ ; \tag{6}$$

$$\left.\begin{array}{l} X(t) \ge 0 \\ U(t) \ge 0 \end{array}\right\},\ \ t = \overline{0, T}\ . \tag{7}$$

And the set of initial states $X(0)$ – is put:

$$X(0) = X^0,$$

here (1) – criterion of management efficiency;

(2) – management of the movement of a managed object;

(3) – permissible management range;

(4) – limitations for phasic coordinates;

(5) – non-negativity of phasic variable and managing parameters.

By the stochastic model (3)–(7) it is possible to define a great class of transport flows optimal management objectives.

For the solution of the objective we shall use a two stage scheme of optimisation. Here in the first stage it is stated that $\xi = 0$ and the solution is sought of a determined objective (programme trajectory), but in the second stage it is considered that ξ is a small deviation and a minimisation objective of the occurring deviation from the programme trajectory is solved.

Thus for the search of the programme solution the initial objective will be written as follows:

$$\begin{aligned} &J_0(X,\ U,\ t) \to \max; \\ &\Delta X(t) = \varphi(U,\ t); \\ &l(t) \le U(t) \le f(t); \\ &X(t) \le g(t). \end{aligned} \tag{8}$$

The solution of this discrete optimal management objective may be obtained using the discrete maximum principle or traditional methods of network solution which as a rule tend towards the solution of a static objective in a relevant deployed network.

Let us presume that the solution of the objective (8) has been obtained and it is of the following shape $\widetilde{X}(t)$ and $\widetilde{U}(t)$. Now, assuming that interferences ξ are sufficiently insignificant, we shall seek for the solution of the objective (3)–(7) in the shape of:

$$\begin{aligned} X(t) &= \widetilde{X}(t) + y(t); \\ U(t) &= \widetilde{U}(t) + v(t), \end{aligned} \tag{9}$$

here $y(t)$ and $v(t)$ are small successions as well as in ξ. Having inserted (10)

$$X(t+1) = X(t) + B^{+}U(t) + B^{-}U(t+1),\ \ t = \overline{0, T-2}; \tag{10}$$

into the initial issue (3)–(7) and having deployed the functions φ, l and f into the line according to y, v, ξ and leaving only linear members we shall obtain:

$$\begin{aligned} &\Delta y(t) = a(t)v(t); \\ &y(t) = g(t)\xi + \bar{g}(t); \\ &\bar{l}(t) + \theta(t)\xi \le v(t) \le \delta(t)\xi + \bar{f}(t); \\ &\bar{g}(t) = g(t) - \widetilde{X}(t); \\ &\bar{f}(t) = f(t) - \widetilde{U}(t); \\ &\bar{l}(t) = l(t) - \widetilde{U}(t); \\ &\alpha = \left(\frac{\partial \varphi}{\partial \xi}\right),\ \ \theta = \left(\frac{\partial l}{\partial \xi}\right); \\ &\gamma = \left(\frac{\partial g}{\partial \xi}\right),\ \ \delta = \left(\frac{\partial f}{\partial \xi}\right). \end{aligned} \tag{11}$$

Here all the derivative programme trajectories are calculated along the system (i. e. at the zero meanings of ξ, v, y). In the second stage for various objectives the functional, which has to be minimised, may be of different expression. In general shape we shall put it as follows:

$$J_1(y, v, t) \to \min . \tag{12}$$

Further, in the second stage, we shall solve the objective identifying the correcting management $v(x,t)$ and the reaching minimum to functional (12) to the conditions (11). For finding $v(x,t)$ it is necessary to know how to measure present solution diversions from that of the programme, at least at relevant discrete moments and to select correcting impacts according to the results of this measurement. The objective is solved by the mechanism of reversible synthesis. However, in general case, there are no regular methods of making the reversible mechanism. We shall apply the above said general solution sequence for the 1–4 objectives. After restoring (9). into the conditions and after linearization, we shall obtain:

$$\begin{aligned} & y(t+1) = y(t) + B + v(t) + B - v(t+1);\ y(T) = y(T-1) + B + v(T-1); \\ & y(0) = 0; \\ & \bar{l}(t) + \theta(t)\xi \le v(t) \le \delta(t)\xi + \bar{f}(t); \\ & y(t) \le \gamma(t)\xi + \bar{g}(t). \end{aligned} \tag{13}$$

Further we shall state that the quantities $\theta(t)$ and $\delta(t)$ for each t cannot have a meaning with various symbols and the quantities $\theta(t)\xi$, $\delta(t)\xi$ and $\gamma(t)\xi$ may be positive and negative as well.

Let us take the criteria of the second stage for the objectives 1–4.

1 Objective.

$$y_n(T) \to \min. \tag{14}$$

2 Objective.

$$\left| \sum_{t=0}^{T} (R(t),\ v(t)) \right| \to \min . \tag{15}$$

3 Objective.

$$Y_n(T) \to \min . \tag{16}$$

if $\theta(t) = \delta(t)$, for all branches of a lot $\Omega(t)$.

4 Objective.

$$\begin{aligned} & \left| \sum_{t=0}^{T-1} \left[(C(t),\ v^2(t)) - (R(t),\ v©(t)) \right] \right| \to \min; \\ & v^1(t) + v^2(t) = v(t); \\ & v^1(t) \le \delta^1(t)\xi,\ v^2(t) \le \delta(t)\xi . \end{aligned} \tag{17}$$

Further, basing on theoretical research, it would be possible to make the analysis of the distribution (according to time) of flows of cars entering a customs post as well as the analysis of their distribution in to separate customs lanes. It would also be possible to identify the idle time of transport means caused by customs procedures, to identify the dependence of the time of services given to carriers in proportion to the amount of transport flow, to calculate and to assess the optimal selection of transport amount for inspection in customs during a certain period of time.

4. Practical Assessment of the Theoretical Research of Transport Flows

The theoretical research of freight transport flows allows to make a detailed analysis of freight flows enabling the elaboration of the recommendations for the improvement of customs inspection procedures. Basing on this the analysis of freight structure and distribution according to countries would enable to prepare the most influential forecasts of freight transport by separate customs-houses.

The stochastic management model obtained as a result of the theoretical research of freight transport flows enables the determination of a great group of optimal freight flows management issues, such as the issue on maximum dynamic flow in the network, which would allow to calculate maximum transport rate in a customs post; the objective of minimum cost, defining the extent of transported flow filling in the dynamic set of the pane, the objective the essence of which is the determination of minimum quantity of international transport means allowing efficient scheduling of transport traffic.

5. Conclusions

1. It is important to define and to analyse transit transport flows, to identify their theoretical distribution in proportion to customs-houses and to investigate how busy they are with transport means.
2. Basing on the assessment of formulation of the objectives of management of transport flows and on the indeterminacy of external impacts, it is possible to carry out a more detailed analysis of the distributions (according to time) of flows of transport means entering customs, as well as their distribution in to separate customs lanes. It also enables the definition of dependency on the extent of transport flow, as well as allows the calculation of choosing optimum transport amount for the inspection in customs-houses during a certain period of time.

References

[1] Powell Warren B. Carvalko Tassio, A Real-Time Optimisation of Containers and Flatcars for intermodal Operations. *Transportations Science*, Vol 32, No 2, May 1988, p 110-126.

[2] Nuzzolo A., Russo F., Cristali U. A Doubly Dynamic Schedule – based Assignment Model for Transit Networks. *Transportation Science*, Vol 35, No 3. August, 2001, p 268-285.

[3] Gattorna D. W. Walters. Managing the Supply Chain. A Strategic Perspective. Macmillas Press Ltd., 1998. 310 p

[4] Coule J. Bordi E., Carinato J. Transportations Third edition. USA, 1999. 525 p

[5] Transport of fast Changing Europe. Vers un Reseau European des systems de transport by Group Transport 2000 Plus. Brussels, 2000. 90 p

[6] Baublys A. Introduction to the theory of transport system. (Transporto sistemos teorijos įvadas). V.: Technika, 1997. 298 p (in Lithuanian).