



THE IMPROVEMENT OF HAZARDOUS GOODS TRANSPORTATION TECHNOLOGY

Nijolė Batarlienė

*Dept of Transport Management, Vilnius Gediminas Technical University,
 Plytinės g. 27, LT-10105 Vilnius-16, Lithuania. E-mail: nijbat@ti.vtu.lt*

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Abstract. This article analyses the conception of the improvement of hazardous goods transportation technology as well as its theoretical principles. Basic organizational aspects of hazardous goods safe transportation are also represented. Effective and safe hazardous goods transportation is possible only using good informational supply. Process modelling and the creation of hazardous goods transportation informational system can improve each hazardous goods transportation technological process. This system should join its components on the whole and coordinate state institutions. The article studies the experience of foreign countries in the creation of informational systems. In the world developed countries various methods of safe dangerous goods transportation are used. This article analyses the types of informational technologies application problems, shows their schemes. It is noted that the solution of transport technology problems is based on the improvement of technological supply, the rational usage of informational modelling methodology of the whole transportation process.

Keywords: hazardous goods, transport, requirements of transportation, provisions structure model.

1. Introduction

Legislative basis of hazardous goods transportation, the analysis of carriage extent characterizes the demand of hazardous goods transportation, the degree of development and describes organizational-technical means, seeking to organize a scientifically reasoned process of hazardous goods transportation.

In every day life from the viewpoint of road safety, a vehicle, which carries hazardous goods, is treated the same as every other means of transport. Any particular safety requirements are not asked for. However, during a vehicle crash or a traffic accident, despite subsequences of every vehicle crash, due to after-effect a hazardous load gets into surrounding environment. If during the biggest accident several or many people die, several or many people are injured, during the vehicle crash with the means of transport, which carries a hazardous load, hundreds or thousands of people can be killed or catch a disease. Besides, the consequences of a traffic accident can't be evaluated at once, because the impact on human health and life may appear even after many years. It looks like after eliminating the consequences of a vehicle crash, there can't be any effect of hazardous load spill on environment and directly on a person. Though it isn't so. Even having up-to-date achievements in research technologies, it is very hard to estimate, how deep hazardous substance

affected the soil, whether it reached it and how much ground water is polluted, and the concentration of the hazardous substance in the soil after the spill. The devices may not notice all these affects in the air or water, but who can predict the harm of hazardous substances to plants, animals and eventually to a person?

The totality of the problems analyzed in the article makes:

- there are still not enough conditions for safe hazardous goods transportation in Lithuania, though they are necessary, because transportation of hazardous goods is one of the most difficult and asking for the biggest safety carriage technologies;
- it is not possible to supply necessary hazardous goods transportation information in short terms;
- there is no opportunity to coordinate hazardous goods transportation by all kinds of transport in Lithuania;
- there are no worked up requirements for hazardous goods transportation in Lithuania, which would allow supplying with necessary information about hazardous goods carriage with expedition.

Bearing this in mind, it is needed to create scientifically based methodology, which would allow fast informational exchange during hazardous goods transporta-

tion, coordinate transportation by various kinds of transport and create informational – technological models, which would be the foundation for the creation of dangerous goods transportation informational system.

In Fig 1 a scheme of organizing the hazardous goods transportation is given, which includes all most important provisions and regulations, as well as people and means involved.

2. Experience of foreign countries in creating informational systems

Informational systems are used in all kinds of transport. With their help, work of certain kinds of transport is being planned, managed and controlled. In Western

European railways informational systems are being fitted near the borders of states. They assist in making the traffic quicker. One of such systems like HERMIS could be mentioned [1]. Companies and organizations, which carry loads by marine, inland water and air transport, lately expanded their informational systems. As many flight companies cooperate in air transport, special informational systems are being created for them. Some of such systems like computer reservation systems AMADEUS and GALILEO could be mentioned which join travel offices, net of hotels, automobile rent companies [2, 3]. These systems play a big role when market is being created. Marine and inland navigation ports have created their own computer informational systems to coordinate information between the consignors and car-

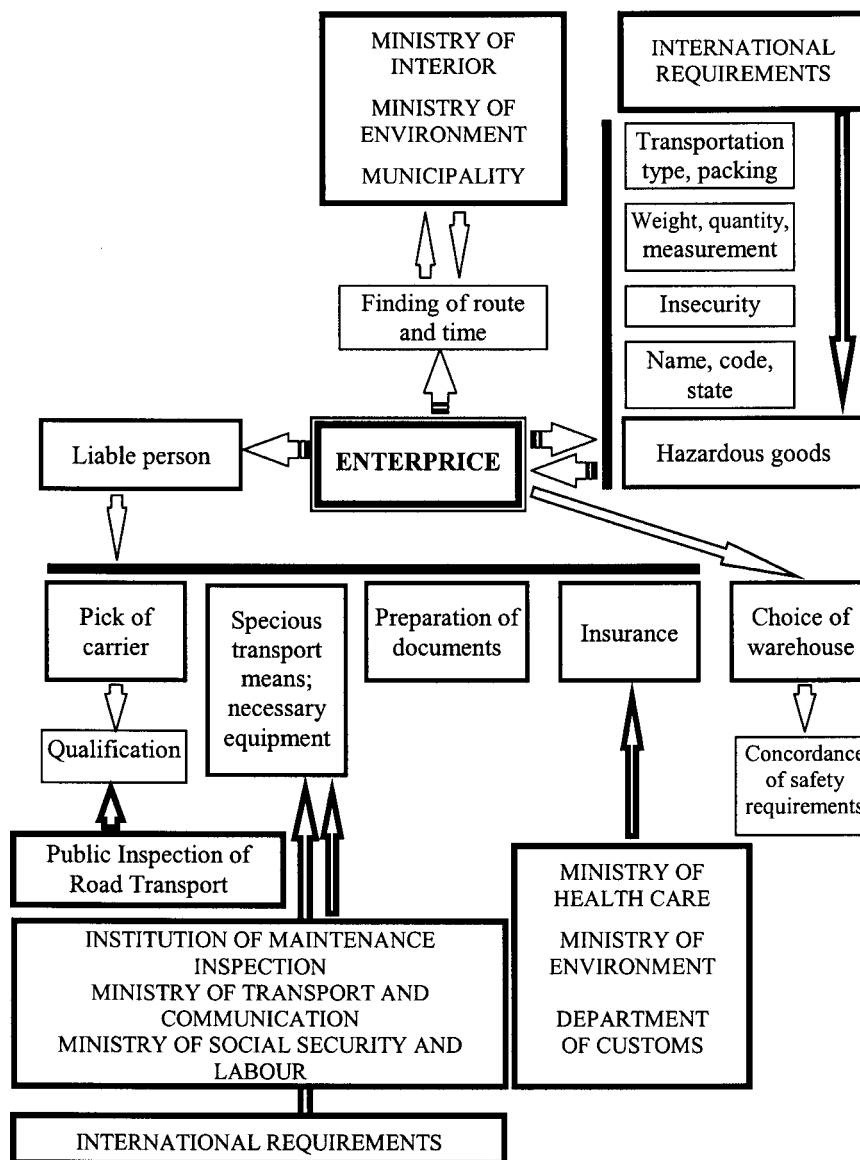


Fig 1. Organization of hazardous goods transportation

riers, between the brokers and agents. For example, Bremen's port's data-bank in Germany, created in 1973, includes more than 100 ports and communication companies, where work planning and process control methods in marine ports are created and fitted. They use COMPASS computer technique [4]. Hamburg's port's data communication system DACOSY [5], Rotterdam's – INTIS [6]. Marine and air ports create interneccine informational systems, which help to affiliate good and comfortable relations. They are needed sending goods between different logistic links. Such links also include customs institutions. Their role is important transporting goods through international routes.

Such widely used and interdependent informational and processing systems as ALFA, CIS and LOG-LUFT can be mentioned [7]. System EDV is created to perform customs formalities. It integrates all participants of load processing in air transport.

The task of communicational systems is not only to draw into the communicational system's programmed control net in big ports, but also to give opportunity for small enterprises to connect to the informational net, without making big investments. Some of such communicational systems are: SEEDOS, TALDOS, ZODIAK, GEGIS, CONDICOS, SHIPS, HABIS [8, 9].

In developed countries many different means ensuring safe transportation of hazardous goods are being used. One of such means is to set a route when carrying hazardous goods by road transport vehicles. Route establishment helps to improve transportation safety:

1) Carriers have to go by conditionally safe roads. This reduces the possibility of accidents with a vehicle, which carries hazardous goods;

2) Route control may soften the consequences when hazardous substance gets into the environment after the vehicle crash by rounding populous regions, places where valuables are kept or protected natural areas;

3) Determination of routes enables local firefighters and rescue workers to concentrate forces and equipment in the hazardous to this point of view area and to make exact incident liquidation plans.

Hazardous loads have to be marked according to set requirements seeking to ensure the bigger safety of hazardous goods transportation. In the Swedish national examination and research institute permanent packing investigations are being made, searching for cheaper manufacturing materials, seeking that these materials satisfy the requirements described in Recommendations. This institute despite the scientific researches also makes package experiments (primary and permanent) for producers in Sweden and foreign countries [10].

The establishment of a similar experiment center in Lithuania would give the possibility for Lithuanian industrialists to make packing, which satisfies international standards. And this could make the carriage safer.

3. Safety requirements for the transportation of hazardous goods

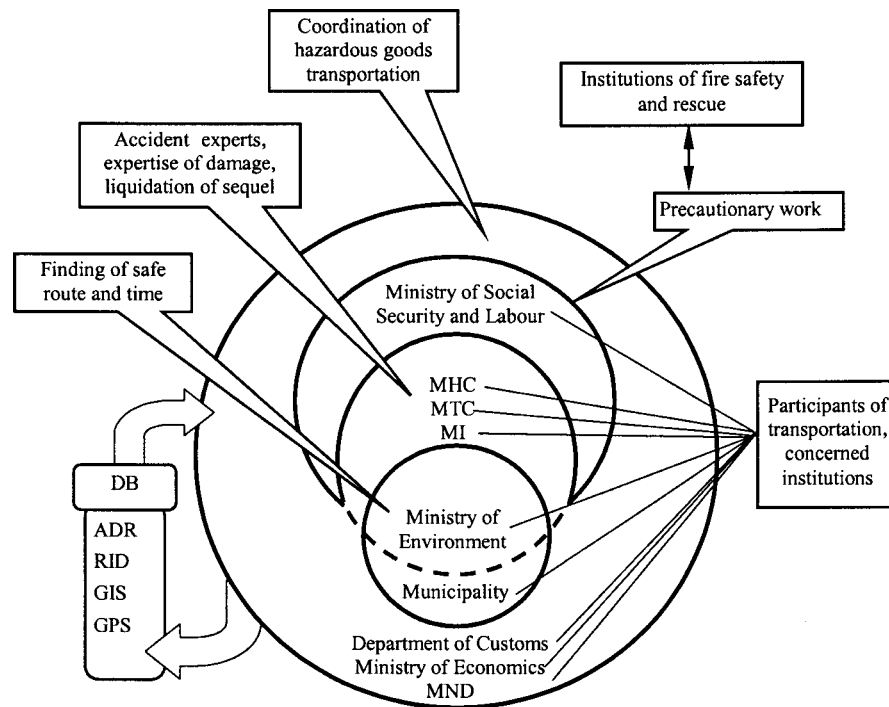
Keeping in mind the experience of Western countries, the following safety requirements for hazardous goods transportation could be emphasized:

- Tunnels: limit transportation through tunnels.
- Routes: routes should be selected according to the situation, because there are some roads where transportation, without having a special permission, of hazardous goods is forbidden, if roads are not fitted for the transportation of hazardous goods. General statement indicates, that hazardous goods should not be transported close to the habitable areas.
- Bad weather conditions: when visibility on the roads is bad, it is raining, snowing or foggy, the transportation of hazardous goods in major cases should be forbidden. Bad weather conditions are when visibility is less than 200 meters. Some hazardous materials should not be transported, when roads are slippery.
- Ferries: special requirements for the carriage by ferries should be set down. Corresponding ferriage requirements should be applied for every means of the transport, which carries hazardous goods. In some cases the ferriage of hazardous goods should be forbidden [8].

Analyzing juridical and technological regulation of goods logistics, the organization and control of hazardous goods transportation, we can see that in every sphere of logistics many ministries and other interested institutions take part. These institutions should be joined together into one collaborative system. It is necessary to do that, because at this moment they can't interact closely, the required information is received only after some time, insufficient expedition and there is no united spread of information. Joining all the system into a net, using informational technologies, and working in the real time schedule could solve this problem. Created informational system (IS) should eliminate existing limitations:

- Inefficient decision making because of the lack of source information;
- Different software used by institutions;
- Big material expenditures (paper, manifold, mail, couriers et cetera);
- Too long decision making;
- Inefficient work of specialists with permanent information preparing new and auditing old decisions.

Having analyzed the limitations and knowing all functions of institutions, controlling the transportation of hazardous goods, a theoretical model of informational system, joining all these institutions, is made (Fig 2).



There are:
 MHC – Ministry of Health Care;
 MTC – Ministry of Transport and Communications;
 MI – Ministry of Interior;
 MND – Ministry of National Defence;
 DB – Database Management System;
 GIS – Geographical Information System;
 GPS – Global Positioning System.

Fig 2. Theoretical model of information system scheme

All functions of ministries and other interested institutions are reflected in this model, their interdependence, data flows. Data flows coming from all institutions which control carriage of hazardous goods to the segment of carriage participants and interested institutions and backwards, are marked by thin lines. Circles mark functions of institutions.

The grand circle joins the institutions that coordinate transportation of hazardous goods:

- Ministry of Transport and Communications (MTC) coordinates the transportation of all hazardous goods, prepares documents, associated with expertise, safe transportation, vehicle certification and control;
- MI (Ministry of Interior) coordinates the transportation of hazardous goods by roads;
- ME (Ministry of Environment) coordinates the performance of some hazardous goods transportation additional requirements concerning environmental protection;
- MND (Ministry of National Defence) – some goods

of first insecurity class also goods belonging to dependent or any other defence institutions are coordinated by this ministry;

- MHC (Ministry of Health Care) coordinates the training of the first-aid giving for people who work with hazardous goods;
- Ministry of Social Security and Labour coordinates the suitability and supervision of transportation equipment that might be insecure;
- Ministry of Economics coordinates the transportation of hazardous goods which are included into a list of strategic goods and technologies;
- Department of Customs coordinates import/ export/ transit transportation, controls insurance policies;
- Minor circle joins the executives of accident prevention work;
- Ministry of Social Insurance and Labour (MSIL) implements the prevention of equipment, used for hazardous goods transportation, that might be insecure and supervises;

- MHC takes part in prevention work, organizes and gives personal and public medical care services, teaches participants how to give the first-aid;
- MI together with fire protection and rescue institutions does prevention work;
- Ministry of Environment (ME) makes environment researches in the areas, where hazardous goods are being transported;
- Ministry of Transport and Communication (MTC) coordinates all prevention activity, prepares documents, trains advisers for safe transportation questions.

In the third circle which joins the functions of accident expertise, evaluation of losses, and elimination of outcomes, MHC, MTC, MI and Ministry of Environment are written. Each of them according to its competence implements corresponding tasks:

- MHC does expertise, evaluates made and imminent harm to human health, provides medical care services in case of accidents;
- MTC establishes expertise service, which makes expertise of accidents with hazardous goods and evaluates made losses, prepares all documents needed for expertise;
- MI takes part in expertise of accidents with hazardous goods in road and railway transport in eliminating consequences and evaluating damage;
- Ministry of Environment evaluates environmental damage, lays claims and gives actions to the guilty parts in hazardous goods transportation to make amends for damage, made to environment, makes environmental investigations at the accident places, where hazardous goods were transported.

The smallest circle joins the institutions which discussed among themselves, set routes and time for hazardous goods carriage.

Every mentioned institution supplies proper information for transport participants and interested institutions about the data, which is in the sphere of its competence, also gets information from carriage participants.

IS gives opportunity for all the institutions to use integrated database, where information about geographical conditions is stored, regulations for hazardous goods transportation, customs and existing rows, state of roads and driving conditions; these institutions also give their own information, able to be used later for future research making and prognosis implementation.

Only having a good informational system, hazardous goods can be effectively and safely transported. When making modelling of processes and creating informational system of hazardous goods transportation, every technological process of hazardous goods transportation can be improved. This system involves a complicated

whole of interrelated components (loading of hazardous goods, transportation, marking). These components are interdependent and when IS is being created, one has to see their whole picture.

Informational model of hazardous goods transportation allows processing of information quickly and productively, supplying with necessary regulations and requirements with expedition for safer transportation of hazardous goods and effective work: selecting containers, determining maximum amount of hazardous goods, allowable norms for transportation, composite loading and insurance, preparing needed documents and making many other decisions.

The creation of an informational system of hazardous goods transportation in Lithuania would make the work of all the participants of hazardous goods transportation much easier. This system could enable to carry goods much safer because it will ensure the qualitative and effective transmission of information between various links of a transportation process.

4. ADR and RID – as informational system

Informational system of hazardous goods transportation in Lithuania has to be based on ADR and RID regulations because:

- It is a whole of means which enable users to manipulate with regulations for hazardous goods transportation;
- It is a methodological base for safer and more perfect transportation of hazardous goods;
- It is a united program, regulating transportation of hazardous goods, predicting juridical and technological basics of hazardous goods transportation.

Computer variants for international transportation of hazardous goods by roads (ADR) and railways (RID) are already prepared, also regulation requirements for hazardous goods transportation by international roads are fitted for the transportation inside the country, prepared requirements for hazardous goods transportation control for experts and inspectors, according to the ES directives and other work. All this gives an opportunity to create an informational system, because this work can be treated as pre-projective work. This work enables to improve a transportation process and to create an informational system. It describes the necessity of creating a methodological basis for safer and more perfect transportation of hazardous goods.

5. Modelling of formal data set structure

Data set structures of hazardous goods transportation are separated considering peculiarities of their data-processing technologies, trying to bring stored data closer

to its sources and users. It is thought that the main user of informational system is a participant of hazardous goods transportation.

While sorting data according to different criteria, particular layout of these criteria enables to direct projection of transport technology to a certain direction. The essence of project depends on this direction. When changing the order of layout we get new projects of transport technology. Data can be added, a part of data can be changed and a part of it may be removed. This can be done without changing the essence of a formal system.

Regulations of hazardous goods transportation have to be modelled till the indivisible level so that they wouldn't have any exceptions and references to other regulations [11]. General basis of regulations about transported hazardous goods, their amounts have to be formulated in this way. Transportation of goods and formulation of regulations concerning their conditions in the database have to be separated from conventionality of changing software.

A system has to process information quickly, supply with necessary requirements and their fragments for hazardous goods transportation with expedition, correct and renew them.

When modelling a structure of hazardous goods transportation regulations and projecting informational system of hazardous goods transportation, three principles may be distinguished:

- Complexity principle;
- Decomposition principle;
- Hierarchy principle [12].

The essence of projecting a complexity principle is: when projecting a hazardous goods transportation system it is important to analyze as much comprehensive as possible, to evaluate and keep the most essential relations, which are in the operating object as well as in the operating system, also between the outside and inside of informational system. Complexity helps to evaluate assumptions, conditions and interaction of different elements more comprehensively and thoroughly, when the computerizing object of hazardous goods transportation is being analyzed. This principle also helps to determine factors, which affect the quality and efficiency of the system, as well as to seek for the most efficient solutions.

Decomposition principle is also important projecting the structure of an informational system. It describes the separation of the whole into parts, seeking to analyze, estimate and project each of them without reference to others. This is the separation of a difficult task to easier ones: for example, sender of data scheme, carrier of data scheme, receiver of data scheme and so on. Database of hazardous goods transportation is separated (structuralized) according to the conveniences of its data-processing technologies, but logical entity and meaningful links between the separated parts have to remain unharmed.

Structuring and analyzing of hazardous goods transportation regulations and database of informational system according to the degree of particularity is determined by a hierarchy principle. Structuring is proceeded according to several degrees of particularity. We are going to study more widely the essence and the usage of methodology of this principle.

Several methods can be used for the restructurization and modelling of international regulations for hazardous goods transportation. All of them are related to horizontal or vertical hierarchy method. Its essence: in the highest level of hierarchy, identification number of hazardous material given by United Nations' organization and name of hazardous material is taken [13]. These records are considered not only as beginning of hierarchy, but also as the main object.

To prepare hazardous goods transportation regulation (ADR and RID) search program, it is necessary to restructure all regulations and to provide the main regulations with indexes and codes. In the regulations of hazardous goods transportation three main data groups can be mentioned:

- General data, which are general to many loads;
- Information data;
- Special purpose (special) data – applied only when goods of certain class are transported.

General and prepared in advance regulations dedicated for some special material are attached to the list of hazardous materials: general, information and special purpose (special). In Fig 3 a model of hazardous goods transportation regulations structure components is imaged.

Knowing the name of a hazardous material or identification number given by JTO, it is possible to find the needed regulations for the transportations of this material. The most important requirements which are used for carriage of one or another load, can be selected using computer according to the system of codes. In this way the main regulation models can be made for all the hazardous materials, for all the participants taking part in the transportation of hazardous goods.

6. Conclusions

1. The given analysis of an existing situation concerning transportation of hazardous goods shows, that hazardous goods are transported not safely, there is no required transportation technology and order, statistical data is not gathered.

2. The analysis of abroad experience shows, that the biggest effect can be reached in the management of a hazardous goods transportation process.

3. The given modelling of regulations concerning transportation of hazardous goods, enables to form the nomenclature of different ADR and RID transportation

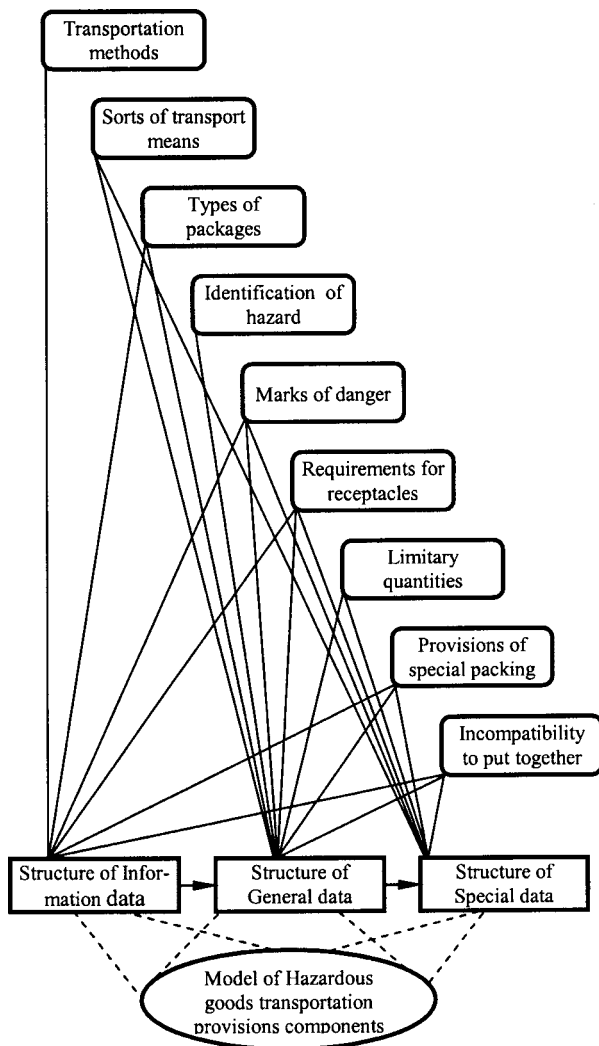


Fig 3. Scheme of model of hazardous goods transportation provisions components

regulations, considering them as the components of the same database. This gives the possibility to make computer search of needed regulations.

4. Process modelling and creation of dangerous goods transportation informational system can improve each hazardous goods transportation technological process.

5. A model of hazardous goods transportation has to be joined to the whole informational system of Lithuanian transport.

6. The suggested informational system model for the transportation of hazardous goods which is used to process information quickly and productively, to supply with necessary regulations and requirements with expedition, is fitted for safer transportation of hazardous goods and efficient work: for the selection of a container, for the maximum amount of hazardous goods and determination of allowable transportation norms, for the possi-

bility of mixed loading and for the preparation of insurance documents and for other decisions.

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