

# INFORMATION MODELLING OF HAZARDOUS GOODS' TRANSPORTATION REGULATIONS

*Nijole Batarliene*

*Vilnius Gediminas Technical University (VGTU)  
Plytines 27, Vilnius LT-10105, Lithuania  
Tel.: +370 2744778, Fax: +370 2745059, E-mail: nijbat@ti.vtu.lt*

## 1. Introduction

There are many hazardous goods in Lithuania transported as transit goods and also inside of the country: by road transport – about 25 %, by railway transport – about 55 %, by pipe transport – 100 %, by air – about 1 % of all goods transported with corresponding mean of transport.

The transportation of hazardous goods is one of the most complicated spheres of transport and it requires the most safety measures because if there is an accident, a hazardous cargo can get into the environment and cause grave consequences.

Lithuania respects the international rules for transportation of hazardous goods. Also the accredited institutes by the government of the Republic of Lithuania, while not breaking the principle of free movement of goods between the countries are estimating restrictions and toughening the requirements for the purpose of national safety, environment protection, safety of traffic, vehicle's, receptacle's and container's suitability for usage.

## 2. Organizing Transportation of Hazardous Goods

It is necessary to regulate, control and check transportation of hazardous goods because of their peculiarities, percentage and real danger. Strict requirements are defined for transportation, packing and marking of hazardous goods, requirements for vehicles, transporters, storage and other logistics functions.

Scientific novelty of the paper is as follows: complex problems of hazardous goods' transportation are considered in the economic point of view, mathematical models of informational and technological processes are prepared, components of hazardous goods' transportation provisions are designed. The aforementioned enables to present informational and technological basis of hazardous goods' transportation in Lithuania.

It is necessary to solve the problem of safety of traffic while transporting hazardous goods complementary – to analyse reliability of the whole system “Participant of traffic – vehicle of road transport (car) – road (street) – environment” (Fig. 1). Besides, the safety while transporting the hazardous goods is affected not only by these main four parts of the system, but also by different kinds of vehicles and society.

Analysis of the capacity of hazardous goods' transportation according to different kinds of transport characterises demands for transporting hazardous goods, development degree of the process and describes organizational-technical means, for the purpose of scientifically motivated process of transportation of hazardous goods.

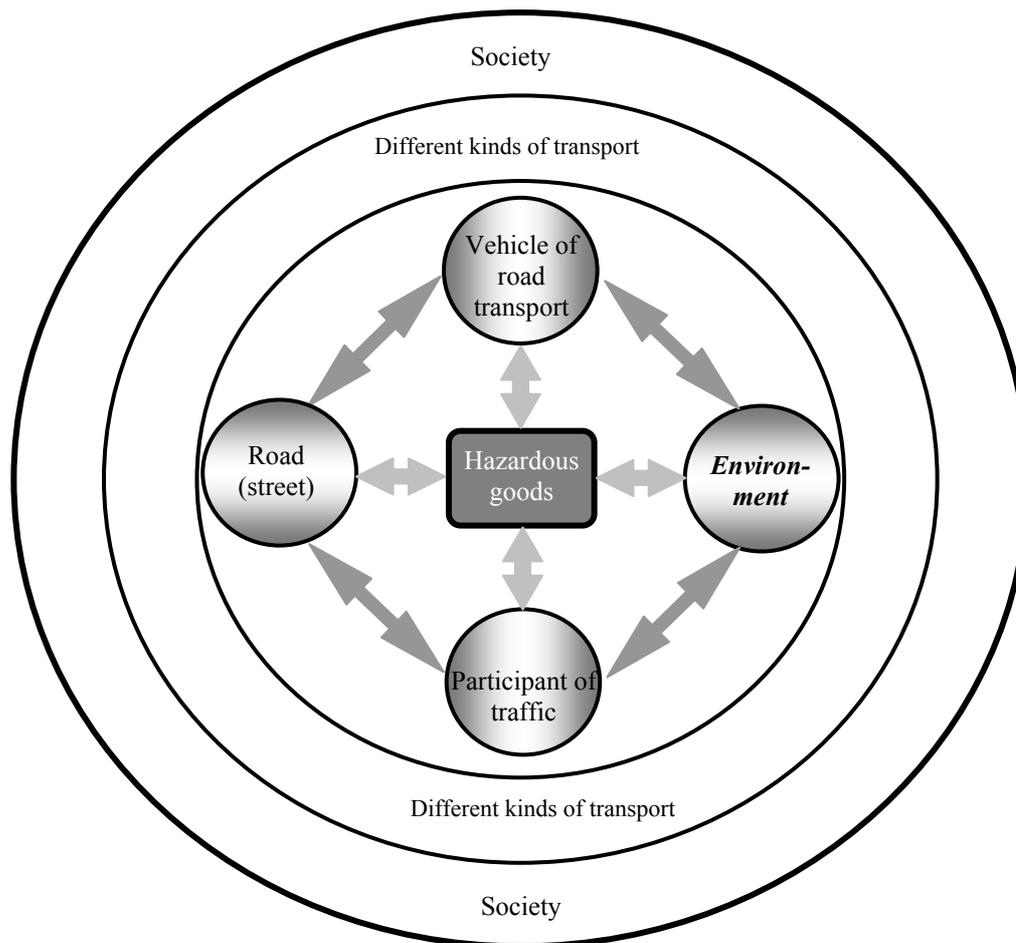


Figure 1. System's "Participant of traffic – vehicle of road transport (car) – road (street) – environment" general structure

Selection of the technical supply of transportation means (vehicle's, container's and package's, mean's of mechanization of loading – unloading work) goes together with the process of organizing transportation, i.e. safe transport according to estimated course, training of drivers and operating personnel. Estimation of course, selection of vehicle and transportation control depends on the administration functions. The informational system, which allows storing with information every link of transportation organizing, is needed to realize these tasks.

To insure safety of transportation and to select means, primary it is necessary to investigate factors, which has influence to danger of transportation. Organizing transportation of hazardous goods, it is necessary to consider such factors:

- Technology of transportation process;
- Interaction with other ways of transportation;
- Estimation of routes;
- System of permissions to hazardous good's transportation;
- Transportation control;
- Elimination of accident results.

All these factors depend on informational supply.

The danger of transportation is determined by three main elements of hazardous goods transportation: capacity of transportation, course of transportation and technology of transportation. Each of these elements has influence on danger of transportation. There parameters and various qualitative and quantitative compatibility features show their level and degree. It is advisable to arrange transportation danger according to degree of danger, which is determined by choosing and estimating technological transportation processes. In this way we estimate danger degree of transportation, as mathematical expected loss magnitude, which can increase, while transporting hazardous goods.

A big role is played in solution of theoretical problems and usage of practical means making the technology of transportation better and improving the process of safe transportation of hazardous goods.

Organizing the transportation of hazardous goods and establishing informational-technological models, it is very important that the hazardous goods are distributed according to appropriate features. This may help to gather concrete information for separate parameters of transportation process.

Characteristics of transportation of the hazardous goods may be as follows:

- Physical-chemical properties of the transported materials;
- Running parameters of containers and packages;
- Degree of danger;
- Conditions that describe specific properties of goods.

Containers may be grouped according to different aspects: according to goods' unit weight, goods' clearance, according to technique of loading-unloading, according to possible ways to load transport's unit, transportation and storage conditions, protection and conditions of outside influence. Otherwise a united system, according to which hazardous goods may be safely transported, can't be created according to these criteria. Thus in this chapter principles of grouping hazardous goods are offered, according to which optimal criterion may be selected, which will be used to establish the probability model of traffic accidents and to create informational system.

The operating personnel and technical means of protection of the surrounding environment determine the principle of grouping hazardous goods according to container. Typical distinguishing feature of grouping: toughness, hermetic, degree of protection from radiation impact, comfort while doing loading-unloading operations.

An important part has grouping of hazardous goods according to transportation reliability criterion – opportunity to assure service of customers, independent from hazardous properties of transported goods.

Other analogical examples of hazardous goods' grouping may be discussed, but all of them have one disadvantage – they don't have criterion, which complementary could describe characteristics of hazardous goods. All types of grouping are based on one criterion – danger.

Methodology of technological processes and listing of hazardous goods' grouping has a big practical benefit: organizing safe transportation of hazardous goods and creating an informational system of hazardous goods' transportation.

It is necessary to bring the definition of traffic accident, as one of the basic terms in the theory of hazardous goods' transportation while analysing a system of hazardous goods transportation by road transport. Such a term can be used solving particular problems and one

of them is as follows: selection of exploitation parameters for specialized means of transport, estimation of danger degree and parameters of goods according to used technological processes, optimal organizational motivation of transportation process and etc. Analytical solution of these problems is complicated because of formalization of hazardous goods' transportation processes and assignment of experimental researches asks for plenty of time and finance or practically these problems are not solvable. Therefore it is advisable to use mathematical modelling methods for hazardous goods' transportation processes. The created models can serve as a basis of scientifically based methodology that lets us:

- to estimate exploitation parameters on which probability of traffic accident depends, and regulations which can diminish this probability;
- to offer typical prophylactic means and to estimate their effectiveness;
- to evaluate probability of traffic accident, which may be subjected to a class of goods.

The following improvement of methodology and the probability estimation of traffic accident used to find all and each optimal parameters of transportation process element, the safest course of hazardous goods' transportation.

### **3. Basic Data Structures of Technological Tasks**

The state and regional transport could be understood as a multi-criteria system. In such case the accepted solutions are not compared by any property, but all the criteria are evaluated. It is complicated to evaluate all transport modes at once. Recently by multi-factorial analysis methods have become the most popular and widely spread. These methods are best suitable for highways, transport corridors defining the main state cities as well as for the identification of European region routes.

Information about freight forwarding within transportation technological process should be transferred by the certain data structures to the places of destination of the transported freight and passengers.

The transportation data and transportation informational tasks system features can be distinguished. The data is divided into four basic groups. This is data about:

- vehicles;
- transportation region together with the transport object disposition;
- transportation process participants;
- freight (goods).

This data is divided into the following logical data accumulations that allow repeating of certain data structure in it:

- consignor's database;
- consignee's database;
- forwarder's database;
- transport vehicle owner's database;
- archive database;
- central transportation database (local and international level).

Such distribution as well as its realization level depends on transport informational network's realization level. Informational transport network has to provide the information exchange for the basic transport process participants (forwarders, vehicle owners, regular consignors-

consignees) among themselves and the centre database. Information about consignment has to considerably outstrip the consignment itself. Data accumulation allows grouping the transportation information basic processing goals.

For the following formal transport technology development it is important to define the data precisely by its forming stages, structures as well as the data features itself. It is necessary that we could recognize the data at any manipulation stage, point or cycle. Such recognition is made using identifications and creating identification system by the certain methods.

#### **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 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 transportation inside the country, prepared requirements for hazardous goods' transportation control for experts and inspectors, according to ES directives and other works. All this gives an opportunity to create informational system, because these works can be treated as pre-projective works. These works enables to improve transportation process and to create informational system. They describe the necessity of creating methodological basics for safer and more perfect transportation of hazardous goods.

#### **5. Modelling of Formal Data Set Structure**

Data set's structures of hazardous goods' transportation are separated considering peculiarities of its data-processing technologies, trying to bring stored data closer to its sources and users. It is considered 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 the project depends on this direction. We get new projects of transport technology when changing the order of layout. 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 formal system [1].

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. 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.

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 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.

The essence of projecting complexity principle: when projecting hazardous goods' transportation system, it is important to analyze as much comprehensive as possible, 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 comprehensive 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 most efficient solutions.

Decomposition principle is also important when projecting structure of informational system. It describes separation of the whole into parts, when seeking to analyze, estimate and project each of them without reference to others. This is separation of 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 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 hierarchy principle. Structuring is proceeded according to several degrees of particularity. The essence and usage methodology of this principle we are going to study more widely.

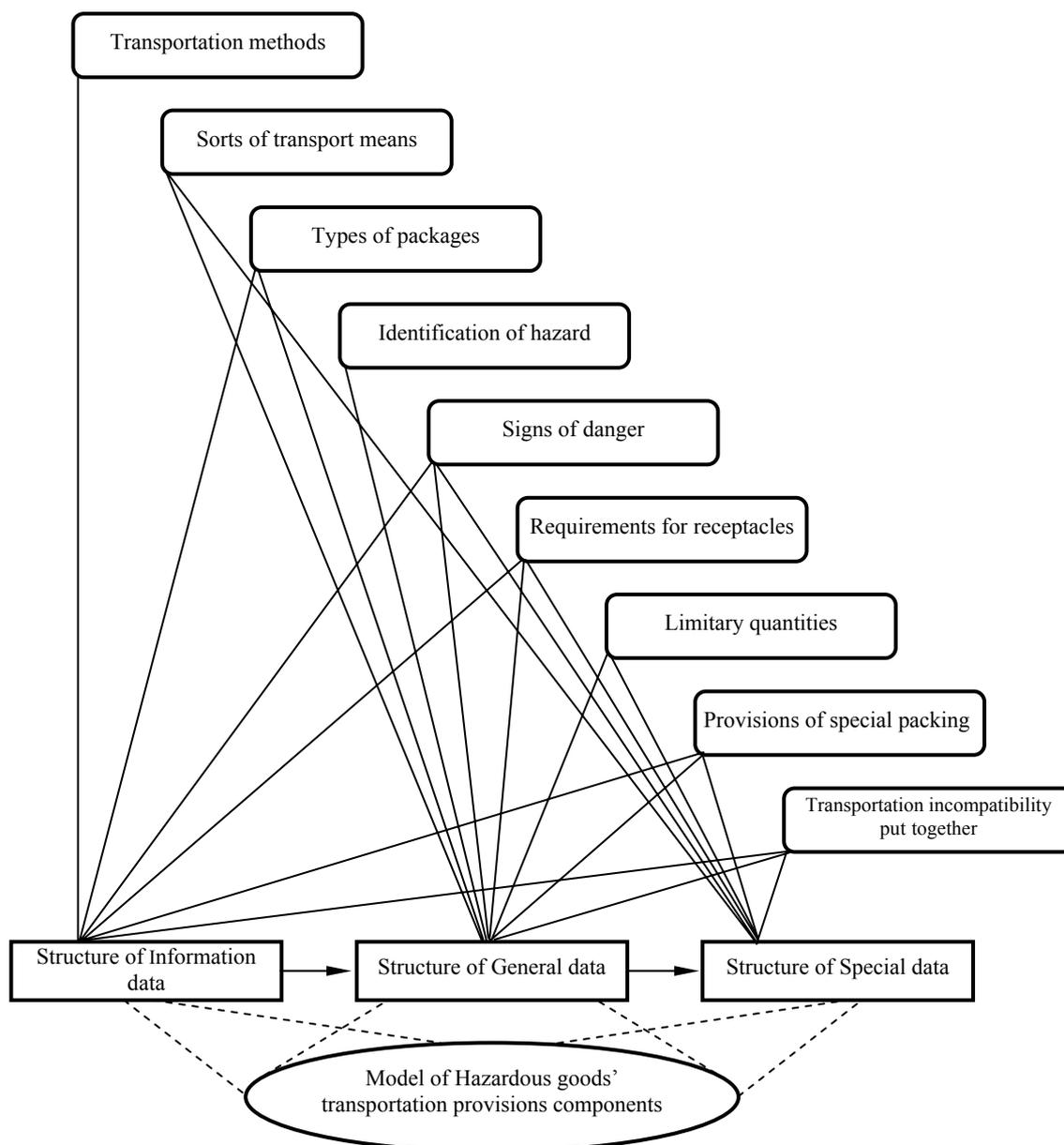
Several methods can be used for restructuring and modelling of international regulations for hazardous goods' transportation. All of them are related to horizontal or vertical hierarchy method. Its essence: in the highest level of hierarchy, identification number of hazardous material given by United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

To prepare the search program of hazardous goods' transportation regulations (ADR and RID), 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 purposed for some special material are attached to the list of hazardous materials: general, information and special purpose (special). In Figure 2 a model of hazardous goods' transportation regulations' structure components is imaged.

Knowing the name of hazardous material or identification number given by JTO, it is possible to find the needed regulations for 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 main regulation models can be made for all the hazardous materials, for all the participants taking part in transportation of hazardous goods.



*Figure 2. Scheme of Model of Hazardous goods' transportation provisions components*

## 6. Modelling of Hazardous Goods' Transportation Processes

Using given codes computer helps easy to find the basic regulations required for transportation certain kinds of materials.

Hazardous goods' transportation informational system's purpose is to process information quickly and productively, to present necessary provisions and requirements fitted for safer hazardous goods' transportation and more effective work: package selection, maximal hazardous goods' quality, determination of allowable transportations norms, composite loading possibility and insurance, preparation of necessary documents and other decisions [2].

ADR and RID provisions enable to form common base of on hazardous goods, mixes, quantities of transported materials, general transportation and etc. The exceptional advantages

of modelling of hazardous goods' transportation provisions and technological processes are as follows:

- Hazardous goods' transportation processes look more pictorially;
- Application resources of information related to hazardous goods increase;
- Important data becomes better understandable;
- Main hazardous goods' transportation data is presented for control.

## 7. Conclusions

- The given analysis of 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.
- The given modelling of regulations concerning transportation of hazardous goods, enables to form the nomenclature of different ADR and RID transportation regulations, considering them as the components of the same database. This gives the possibility to make computer search of needed regulations.
- A model of hazardous goods' transportation has to be joined to the whole informational system of Lithuanian transport.
- 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 possibility of mixed loading and for the preparation of insurance documents and for other decisions.

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