INFORMATIONAL MODELLING OF THE REGULATIONS OF THE DANGEROUS FREIGHT TRANSPORTATION FOR DATABASE MANAGEMENT SYSTEMS

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1. INTRODUCTION

The purpose of this article is to show theoretically and with certain examples the coherence of database management systems' (DBMS) schemes and restructured dangerous freight transportation regulations' base. From the one hand, such coherence requires restructuring regulations into DBMS acceptable structure, and from the other hand – lets forwarders to use database to know how to transport certain dangerous substances.

Restructure of dangerous freight is made neither by scientific organizations, which work, in this particular direction, nor is described in specific literature. Usually text of dangerous freight transportation rules is just changed by means of computer. Therefore, restructure theoretically and practically is a new subject.

There is a plenty of international dangerous freight transportation rules, which are very complicated and inconsequential. It is because of the following reasons:

- Big number and amounts of dangerous freight and its' compounds;
- Properties of different dangerous freight and its' compounds are often partly or completely similar;
- Position coding method well known several decades ago isn't effective nowadays, because of the ever-growing number of substances, compounds and their classes; there is a lack of positions in substance's code to indicate new materials and their properties [1].

Bearing this in mind, first of all, dangerous freight transportation rules should be restructured.

2. RESTRUCTURE MODEL OF DANGEROUS FREIGHT TRANSPORTATION RULES

Restructure is understood as changing dangerous freight transportation rules' structure into the self sufficient elementary dangerous freight transportation regulations' system.

Basic principle of restructure is simple. As dangerous freight transportation rules are based on UNO declared code list of dangerous substances and their compounds, selecting certain dangerous substance's or compound's code, it is possible to find out in the rules how to transport one or another substance or what is prohibited during transportation of this particular substance.

Let dangerous substance's name, code and transportation regulations be:

$$(N+)_i(N-)_i(N)_i \rightarrow T_i\,. \qquad (1)$$

Here: T – is name of substance,

i – UNO code of this material ($0001 \leq i \leq 9999$),

$(N+)$ – regulations, requiring one or another type of transportation, parameters, etc.

$(N-)$ – regulations, prohibiting one or another transportation of dangerous substance,

(N) – technical constants, parameters, units of measure, etc., used not only in transportation of dangerous freight.

From expression (1) we can see, that separate regulations of different substances are similar:

$$n_l^q \equiv n_{l_1}^{q_1}, \tag{2}$$

where $q_1 \neq q$;
$l_1 \neq l$.

It is obvious that the same technical parameters can influence different dangerous freight transportation.

$(N+)$ and $(N-)$ in the expression (1) have only formal differences, because it is not important if transportation regulation confirms the requirement or denies. It is important that regulation would be undividable. Let us say, that a certain regulation consists of two parts:

$$n_l^q = n_{l_1}^q,\ n_{l_2}^q. \tag{3}$$

Then, it is clear that for i_1 substance only $n_{l_1}^q$ part of regulation is valid, and for the i_2 - only $n_{l_2}^q$ part of regulation is valid. Because both parts of regulation have the same code $n_{l_1}^q$, therefore for i_1 substance $n_{l_2}^q$ part of regulation and for i_2 substance $n_{l_1}^q$ part of regulation would be incorrect, misleading.

It seems that such classification of dangerous freight transportation regulations would allow transportation process participant (forwarder, packager, fright-forwarder, etc.) to define himself which transportation regulations are necessary to transport a particular dangerous substance. But it's not the way it is. Because of big number of regulations, their complicated formulation and very frequent dangerous freight transportation regulations' changes by competent organizations, the only person able to define all transportation parameters is specialist-expert. Dangerous freight forwarders unable to use services of such experts for each separate transportation because of physical and financial reasons. To solve this problem it is needed to create dangerous freight transportation regulations' database from those regulations, which are practically required for transportation participants. The sphere of competence of the experts would stay juridical debates concerning breaking rules and development of dangerous freight transportation strategy in the country [2].

Extending expression (1), we have a list of dangerous substances as well as big number of their transportation regulations:

$$\begin{aligned}
&n_1^1, n_1^2, \cdots, n_1^{k_1} \rightarrow T_1 \\
&n_2^1, n_2^2, \cdots, n_2^{k_2} \rightarrow T_2 \\
&\cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots \\
&n_{i-1}^1, n_{i-1}^2, \cdots, n_{i-1}^{k_{i-1}} \rightarrow T_{i-1} \\
&n_i^1, n_i^2, \cdots, n_i^{k_i} \rightarrow T_i \\
&\cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots
\end{aligned} \tag{4}$$

Obviously, when new dangerous substance appears, it's not difficult to continue the list (4):

$$n_{i+1}^1, n_{i+1}^2, \cdots, n_{i+1}^{k_i+1} \rightarrow T_{i+1}.$$

Let any code of substance be R, where $1 \leq l \leq i$, row number – $1 \leq q \leq d$, where d is maximum row number of a certain substance, which has the biggest number of regulations.

3. DATA STRUCTURE

In expression (4) all regulations are classified into several groups according certain similar dangerous freight parameters and the same transportation requirements. Thus, special regulations *(S)* are formed, which concern only certain dangerous substances with the similar parameters. There are 13 types

of such different dangerous substances, i.e. S_j, where $1 \le j \le 13$. It is because at the present moment international dangerous freight transportation rules contain 13 different dangerous substances' classes.

The following general regulations *(G),* are regulations valid for all dangerous substances' classes. These are requirements for package, vehicles, marking of materials and vehicles, etc. Besides, separate dangerous substances' class of special regulations *S*, is classified by certain x positions, i.e. S_j^x. Dangerous substances of the same class and position often have almost the same transportation regulations. Usually only one or couple of regulations differs.

Therefore it is possible to classify all regulations into such open regulations lists (Fig.1):

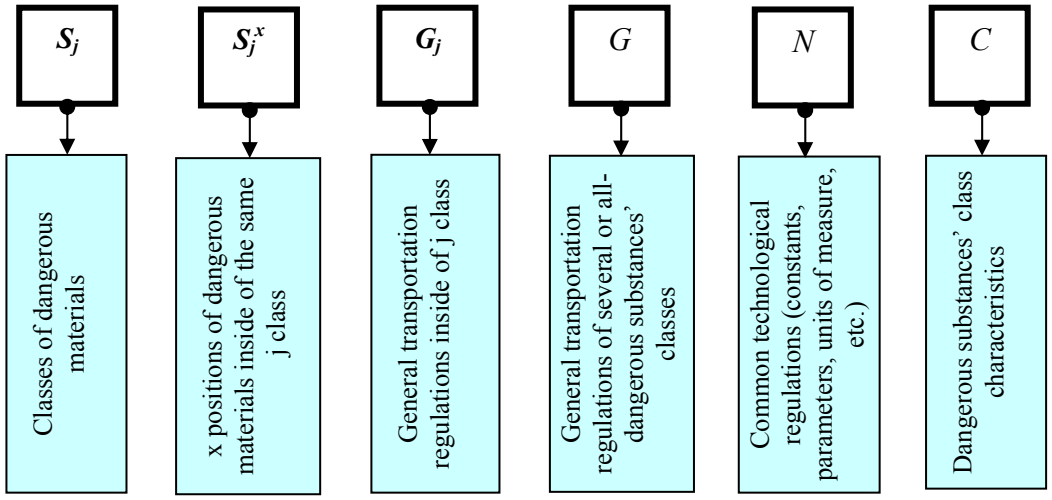

Fig.1. *Scheme of open regulations lists*

The contents of all regulations meant above was explained before or are clear from the list's comments. Only *C* list requires special attention. It has the following characteristics:

- Closed or opened class. Closed means that, according international rules the transportation of substance, which is not in the list, is restricted and special transportation should be organized. If class is opened and there is no substance's name in the list, the substance considers being not dangerous.
- Regulations that allow or restrict transportation of different classes together.

Symbols, described before:

S_j, S_j^x, G_j, *G, N, C*

mean names of the lists, and their regulations, inside of each list, have corresponding natural numbers' coding: 1,2,3,… .

In each list, next to each number there are texts *T*, which mean undividable transportation regulation.

To make things simple, all texts of regulations are marked with *T* letter. Still it is necessary to remember, that T texts irrespectively of similar marking differ one from another, i.e. in the special and general regulations' lists there should be no same texts. In practice, texts of special lists' regulations for different classes can be alike and sometimes even similar. In this case, noticed similarities are transferred into *G* or *N* lists.

At the beginning of this article it was meant that codes of dangerous substances or their compounds are noted by i letter, which has the following interval $0001 \le i \le 9999$.

Therefore it is necessary to divide all *i* codes according their dependence on different classes:

$$\begin{aligned} &1 \text{ class } i \text{ codes are } \rightarrow t_1^1 \le i \le t_2^1; \\ &2 \text{ class } i \text{ codes are } \rightarrow t_1^2 \le i \le t_2^2; \\ &\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \\ &13 \text{ class } i \text{ codes are } \rightarrow t_1^{13} \le i \le t_2^{13} \end{aligned} \qquad (5)$$

Basis structure of data model is transportation regulations' codes, expressed by natural numbers, written next to the code of certain substance. To sum it all up, for any *i* we can write the following (Fig.2):

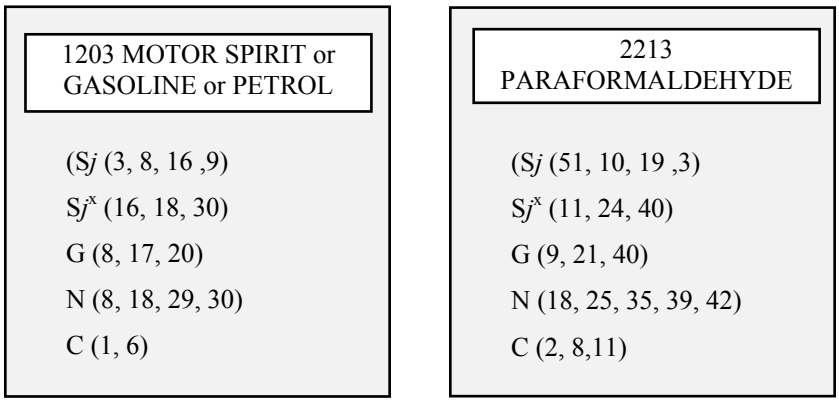

Fig.2. *Examples of the lists of dangerous freight regulations*

Here natural numbers are chosen inconsequentially. They don't mean certain codes, but show the way it has to be represented.

List of expression has to join all existing *i*. If there will appear new dangerous substances or their compounds, expressions have to be made for them, too.

4. ALGORITHM OF FINDING REGULATIONS

For finding any dangerous substance transportation regulation it is enough to indicate it's i code or it's description T, showed in fig.2.

Using indicated substance code or description, *i* is found, which is described by expression (5). The serial numbers of corresponding lists' regulations are found and are changed by corresponding regulations' texts T:

$$i \leftarrow Sj\ (T,\ T,\ldots,T)\ Sj^{x}\ (T,T\ldots,T)\ Gj\ \ (T,T,\ldots,T)$$
$$G\ (T,T,\ldots T)\ N\ (T,T,\ldots T)\ C\ (T,T,\ldots T). \qquad (6)$$

Names of lists' codes S_j S_j^x G_j G N C are not presented while defining texts' variety of i^{th} dangerous freight transportation regulations. It is because they don't supply any additional information for freight forwarder. An exception is S_j, which means dangerous substance class. For it T is necessary to understand other regulations' texts easier.

Before making conclusions, it is necessary to note that represented model of dangerous freight transportation regulations doesn't change or develop the essence of dangerous freight transportation rules. It is in charge of UNO competitive organs able to do this, using possibilities of scientific branches and disciplines. These are chemistry, transportation technology, physics, nucleus theory, etc. The represented model allows freight transporter of any qualification to choose from the variety of transportation regulations necessary ones.

Data set's structures of dangerous freights' transportation are separated considering peculiarities of its 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 participant of dangerous freights' 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 formal system.

5. CONCLUSIONS

1. Created models give possibility to present dangerous freight transportation rules as undividable transportation regulations' lists, which can be extended, decreased or otherwise modified. This allows leaving dangerous freight transportation system unchanged, when rules are changing. It is enough to change regulations' lists.

2. 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 dangerous materials, for all the participants taking part in transportation of dangerous freights.

3. Knowing the name of dangerous material, it is possible to find needed regulations for transportations of this material.

References

[1] Adomėnas P. G. Structural Modelling of International Regulations of Dangerous Goods Carriage by Road (ADR), *Transport Engineering,* 1997, Vol. 2 (15), pp. 4-8.

[2] Batarlienė N. Dangerous Goods Transportation Informational System: Collective monograph. In: *Transport: Technologies, Economy, Environment, Health.* 2003, pp.103-151.

[3] Paulauskas V. Difficulties in Dangerous Goods Transportation via New Independent Countries, *Transport Engineering*, Vol. XV, No 5, 2000, pp.16-22.

[4] The Official European Agreement Concerning the International Carriage of Dangerous Goods by Road (ADR). ECE/TRANS/160, Vol. I, II UN-ECE Inland Transport Committee/ECE, New York, Geneva, 2003.