Risk Analyses of Danger Sources and Humanitarian Aid Supply Chains due to Emergencies

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***Abstract*—Facing the risk in urban area it is very important to increase the sustainability from the environmental, managemental and mathematical points of view. The article deals with the elements of the accident's forecasting and preventing system, detecting hazardous areas and providing the appropriate humanitarian aid supply chain that is needed for the population. Much attention is given to assessing the factors affecting the specific region emergencies. In the article it is proposed to improve the existing emergency liquidation system taking into account the physiographic location.**

***Index Terms*—risks, emergency, humanitarian aid, supply chain, threats, hazards.**

I. Introduction

NOWADAYS, it is of current interest to prevent and liquidize the emergencies. Accident forecasting needs full-fledged hazards analysis. There are many factors that can influence the probability of dangerous events in different areas of urban environments. First of all, it is necessary to recognize the physiographic features and climatic characteristics of the territory. Secondly, we need to consider features of the main manmade threats, including emergency situations in transport, accidents at hazardous factories, fires and explosions, as well as features of biological social threats associated with the spread of various diseases appropriate to this territory. It's important to take into account the rate of social and economic growth. Thereafter developing a set of accidents prevention measures should be based on quantitative and qualitative risks assessment.

II. Risk analyses

The essence and purpose of monitoring and forecasting system is supervision, control and foreseeing of natural and technogenic dangerous processes and external destabilization factors. Regional and territorial monitoring center activities are implemented in several stages. The first step is collection, analysis and presentation to government department the information about potential emergency situations sources and the reasons for their occurrence in the region. The second one is forecasting emergency situations and their scales. Another item is organization and conduct laboratory of chemical-radiological and microbiological analyses of environmental objects, food, feed raw and water, representing a potential risk. Then it's important to think about creation and development of emergency situations database and geographic information system, which will help to organize information exchange. The previous steps are necessary to create itemized guideline to coordinate activities and control the functioning relevant links of the regional and territorial level monitoring and forecasting systems of the emergency situations.

It is of importance to mention that the danger of natural and man-caused emergencies on the flat land is lower than in the zones of complex landscape. It is caused by the presence and distribution of natural and technospheric disaster sources and their repeatability throughout the year. Natural hazard events assessment for an annual period allows to take into account the cyclicity off all the types of sources of natural emergencies inherent to each specific territory of the region. For instance, in the cities of the Mediterranean and the Black Sea regions the most dangerous natural phenomena and spontaneous disasters, which have the possibility of developing into an extraordinary situation are the earthquakes, landslides, mudslides, karst processes, abrasion of the coastal strip, strong winds, rains, snowfalls, high water levels, natural fires. The greatest number of manmade emergencies is caused by fires in the residential sector and organizations, large road-accidents, tunnel-traffic accidents and accidents on communal-energy systems. It is significantly meaningful to analyse the coastal cities because of the density of population and the amount of potential threat. In case of population evacuation there is an extremely high demand for supply of the essential tools, food and water.

The liquidation system of the emergencies must interact with the prevention and monitoring analyses. Solving the problem of population life support, especially in the initial period of elimination, is one of the main aims. The purpose of the life support services is to satisfy physical, materialistic and spiritual needs according to established norms.

III. Humanitarian aid supply chain

Disaster can strike anywhere, at any time. In order to

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overcome these emergencies there must be a proper working supply chain of stockpiles in a needed quality and quantity. It is really very important for injured people, rescue team, doctors and other participants of liquidation of ES. Supply chain in the humanitarian field is characterized by large-scaled activities, irregular demand and unusual constraints in large-scale emergencies, while the business logistics deals with a predetermined set of suppliers, manufacturing sites and stable/predictable demand. But still there is an increasing acknowledgement that disaster response has much to gain from commercial Supplier Relationship Management thinking. This can lead to greater interest amongst academics as well as politicians and the general public [1].

In different countries worldwide there are different rules, laws and structures of management and supply chain of humanitarian emergency aid. Relief organizations and authorities respond by delivering aid to those in need. Many countries have got a lot of experience in this area. According to the statistics such countries are for instance: Philippines, Bangladesh, Japan, Indonesia etc.

Practical provision of humanitarian aid generally has to take place in locations where sophisticated logistics techniques are difficult to implement. The provision of humanitarian aid in different circumstances has led to formation of plenty inadequate logistic [2-7] systems and concentration on funding relief rather than on the processes that support the delivery of these goods. There should be carried out the analyses of the concrete territory with understanding of mostly all of possible risks of damage and the graduation of them from the most damaging to low risky ones. In that case people can organize the stockpiles, warehouses and the supply chains [8] in the most suitable way to react as fast and fully involved as possible.

The most important and vital material resources for such purposes are:

1. stocks of food products (bread, flour, canned goods, butter, sugar, potatoes, vegetables and fruits, baby food, tea, salt, sugar etc.);
2. first aid items (deep metal bowl, spoons, buckets, cups, soap, bedding etc.);
3. stuff property (tents, folding bed, mattress, blanket, pillows, bed linen, underwear and other clothing and footwear);
4. combustible and lubricating materials (motor gasoline, diesel fuel, jet fuel),
5. material and technical means (coal, wood, heating furnaces, kerosene, crowbars, axes, shovels, etc.),
6. building materials (sand, brick, gravel, bags, glass, etc.),
7. communication facilities (radio stations, mobile phone connection);
8. medical property and medicines (tablets, iodine, peroxide, alcohol, etc.).

Also, if necessary, food points should be organized, in case of emergency situations in local area.

The factors which must be taken into account about nomenclature and the scope of stockpiles are the following:

- types of possible emergency situations;
- magnitude of potential damage;
- natural, economic and other features of the region;
- the maximum possible use of available forces and assets;
- the contribution of investment allocated to create the appropriate types of reserves.

IV. Logistic methods

If the area is under the threat of several emergencies it is worthwhile placing more than one warehouse in the appropriate location to minimize the time costs of humanitarian aid supply.

To determine the right places for the warehouse's accommodation it is possible to use a method of optimal locations depending on the transport costs proportional to the rectangular distances. Despite the diversity of decision criteria, the goal of rescue activity is the following: to improve the time response.

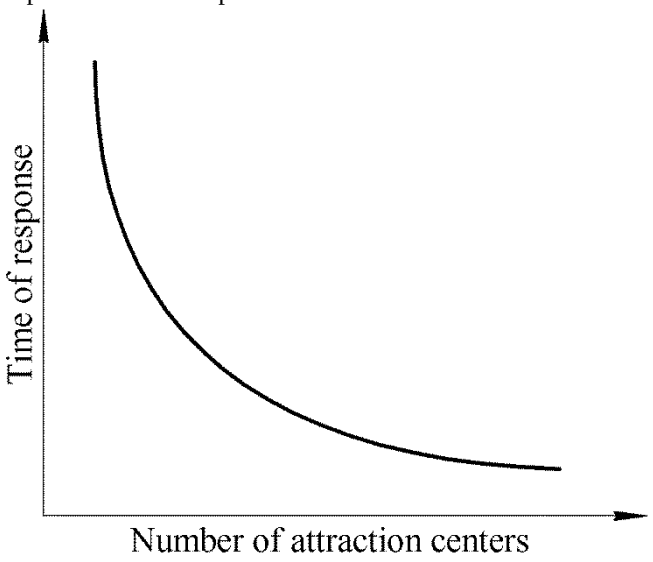

Fig. 1. Relationship between the time of response and the number of attraction centers.

In the problem of finding the optimal position of an object in the supply chain there exists an idea of the influence field. There is a physical analogy that the cities in the emergency is the center of attraction and have their certain weight. The far we move from the city, the less the force of attraction will influence us. It is empirically shown that in the case of humanitarian aid demand the far the injured people are from the warehouse, the less is the probability of timely succour and it is inverse proportional to the delivery time from the storage. This model is called Huff retail model (1963).

There is an approach in which the optimum location of the service center corresponds to a point that minimizes the multiplication of the freight weight and the distance of the carriage (Weber's problem, 1903). When solving this optimization problem, two methods of calculating distances are used:

--euclidean distance (1);
--rectangular distance (2).

Suppose that we have n settlements Pi (i=1,…,n) with an emergency risk. The coordinates of all of them under the threat can be defined (a_1, b_2), (a_2, b_2),…(a_i, b_i) and the way to each point is parallel to x axis and to the y axis. There must be found an ideal distance d (X, P_i) from P_i to localization of warehouse X (x, y). In addition, there should be known freight rates in monetary units per unit of distance (the variable c_i) and the total quantity transported from S to Pi for a period of time (the variable z_i). The product of the last two

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variables is a variable w_i (3).

$$d(X, P_i) = \sqrt{(x - a_i)^2 + (y - b_i)^2} \quad (1)$$

$$d(X, P_i) = |x - a_i| + |y - b_i| \quad (2)$$

$$w_i = c_i \times z_i \quad (3)$$

The aggregate criterion cost function can then be written as (4):

$$f(X) = \sum_{i=1}^{n} w_i[(x - a_i)^2 + (y - b_i)^2] \quad (4)$$

In the case of an emergency first of all the focus is on the minimum distance from the warehouse to the location of an accident. The main criterion of this method is the minimization of transportation costs. In the context of an emergency, the costs of transporting the essential tools will depend on the number of aggrieved persons and the distance to the location of the warehouse.

Due to the fact that transportation costs and time costs are interrelated concepts, employing this method in case of humanitarian supplies we can use an analogy with cost of money and cost of time.

In reality the distance from the warehouse to the emergency areas must be proportional to the density of population and the probability of disaster occurrence in the certain settlement. There are more useful methods talking about the gravity. If you need to analyse n settlements on the map we assign the certain value, which defines the emergency rate. There can be used a material example to find the mass center of this system. There should be a thin surface with several holes which introduce the location of emergency centers. Then we take the appropriate number of gravity bobs bounded with ropes and observe the balance of weights. Worked out point is the mass center and the best location for the warehouse.

The amount and type of necessary material resources on a certain territory must be varied by such criteria as: the type of emergency, the risk of an emergency, the number of population in this area, the population density, the development of the transport network, etc. The list of criteria can be significantly expanded and used in the methods reviewed above.

V. Conclusion

In conclusion it is important to mention that two systems of emergency prevention and liquidizing must fully interact and exchange the actual information beforehand. There should be a unique system of risk forecasting on the particular area based of the physiographic and economic features of the territory to realize the humanitarian emergency aid. Precisely planned supply chain operations are vital in case of emergency, because the huge amount of human lives depends on the rapidity and accuracy of rescue team actions.

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