The International Emergency Management Society
9th Annual Conference Proceedings
University of Waterloo, Canada, May 14-17, 2002

THE SYSTEMS APPROACH IMPLEMENTATION IN EMERGENCY MANAGEMENT FOR FLOODS, TRANSPORT AND TERRORISM PROBLEMS[1]

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Keywords: Decision support systems, emergency situations, Web based, system approach.

Abstract

Technology of using of the systems approach is considered in relation to emergency management processes. The systems approach is concluded in complex analysis of emergency situations, with provision for technical, physical, psychological and social-economic factors. The possibilities of the systems approach are analyzed for decision support with provision for all factors.

The specific feature of the proposed technologies is an interdisciplinary approach to development of intellectual decision support systems, providing efficient methods for exhibits in the field of emergency management problems, which are characterized by greater volume of analyzed information, bad formalized procedure decision making and difficulty in the use of traditional methods of the multi-criteria optimization.

The discussed problems cannot be solved without the use of methods of artificial intelligence and integrations of GIS, mathematical modeling and DSS [1]. The systems approach usage allows development of methods for integer of the class of the uniform problems in emergency management.

A suggested methodology is considered in an example of emergency management, in such situations as floods problems, transport emergency situations, including terrorism accidents and others.

Introduction

Urgency of the problem, regrettably, does not cause doubts. The emergency situations caused by natural and anthropogenous reasons, including terrorism, become ordinary in our lives. The typical particularity of the studies presented in this report is a system approach to consider the problem, under which is researched a whole cycle information handling, from input flow to finishing decision making. The last achievements of the informatics, including development of knowledge based systems (the artificial intelligence systems, expert systems) and decision making computer methods, have set the problem making the systems. Thus allowing redution in the consequences of

[1] The research of this paper was carried out under support of the Russian Foundation for Basic Research (Grant N 00-01-00534)

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miscellaneous sorts of emergency situations, and integration of the experience of decision making, management and undertaking action in emergency situations.

This paper considers methods of decision making system development, founded on knowledge for use in emergency situations. Specific proposed methodologies are concluded in a multidisciplinary approach to the creation of an intellectual decision support system [2], allowing efficient methods for exhibits in the field of emergency management, characterized by greater volume of analyzed information, poor formalized procedure of the inference for decision making and difficulty in the use of traditional multucriterial methods to optimization. The emergency situations which have recently created the most problems, including terrorism, high water and floods, require the development of existing methods of decision making and management [3-4].

Considered in the report is a methodology that can be considered as a continuation effort on system integration of the computer products and verbal methods on new modern level. The methods have an importance to system integration, which will allow uniting the efforts between the developers of different systems. On-persisting efficient systems appear then, when there is a possibility for integration of decision appearing problems of the subsystem created in miscellaneous time, different specialists on different programme bases. In this case the systems are founded on the knowledge of the various people and different scientific disciplines. Herewith, as a result of using the system approach, appears the multidisciplinary knowledge [5-6], and the same as in the traditional scientific world, appears the problem of the general use of different languages of descriptions, differing methods of the decision of the problems etc. [7].

The Group, which includes the author, has a significant length of service in the area of informatics, in accordance with decision making, processing the greater volumes to bad outline information, methods of making the intellectual information systems, and study of the processes of the natural ambience. They were designed row of the applied systems in this area. The problem is considered of integrations of different aspect of buildings decision support systems in row of the application domains.

The methods have great importance to system integration, which allow uniting the efforts of different system developers [8-9]. On-persisting efficient systems appear then, when there is a possibility to integrate decision appearing problems of the subsystem created in miscellaneous time, different specialists in the field of informatics, decision-making, hydrology, economy, social sciences, and transport, on different programmed bases. In this case the systems are founded on the knowledge of the various people and different scientific discipline. Herewith as a result of using the system approach, appear the междисциплинарные of the knowledge, and in the same way as in traditional scientific world appears the problem of the general use of the different languages of the descriptions, different methods of the decision of the problems etc.

Modern information technology and decision making in emergency situations

Management in emergency situations and methods of decision making has recently become a much more fruitful area of exhibit of the modern methods of informatics [11]. The actual problem is an integration of the facilities telecommunication, founded on knowledge (the artificial intelligence) and computer methods of support decision making (Decision Support Systems - DSS). The system approach to making identical methods of the decision of the problems, choice corresponding to technical facilities and organizing decisions allow hope for a qualitative jump result in this area [12].

On this background by exception is a scientific problem "Decision making in exceeding situations". This area is solely fruitful for using the complex of the modern methods of informatics and, primarily, methods of artificial intelligence. There are many events when it is necessary to come to a conclusion in a short time period (from several minutes to several days). This range of time,

makes it difficult, and sometimes impossible, to invite the consultant, collect the specialist, conduct the consultation or council-boards and etc. In this case, it happens to rely upon opinion of the computer, though this is sometimes fraught with unpredictable consequences. It should be emphasized that in these situations (and in many others too) computer systems decision making is not wanted by choice, but becomes the necessary variant in decision making in conditions limited by resources.

In the opinion of authors, the system approach to a given problem means the analysis of all aspects of the considered problem, продумывание and modeling of the full technological cycle of information handling, commencing from entering and receptions to information before decision making. The Main idea is concluded in agglomeration of the knowledge in computer form knowledgebase, thus allowing their use for decision-making.

We shall consider that there exists a certain application domain, in which knowledge (in the manner of recommended decisions and the sequences action) is accumulated on the basis of consideration of emergency situations of a certain frequency. Industrial damages pertain to such situations, and natural disasters (the high water, tsunami, earthquakes). In this case the frequency of the event was not so great as was a real possibility to train and drill the personnel and persons responsible for decision-making, but consequences non-optimal decisions can be significant.

For considered problems telecommunication possibilities systems, founded on knowledge, are a principle component, since significant time can be needed for accumulation of the knowledge about action in free-lance situations on each object. However, the class uniform object exists, for instance enterprises of the certain type, seaports, populated points in places, subject to high water, and etc. In this case, it is necessary to provide the integration of the knowledge about uniform emergency situations on space portioned object of one type. One possible method of reaching a decision for this problem is the creation of a computer network for spreading knowledge on the uniform object, obtained as a result of a posteriori analysis action (or inaction) in free-lance situation. This network can work in mode "on--line'" or "off-line", be organized as uniform or hierarchical, can be in the manner of stars with analytical center and etc. This depends on the concrete sphere of exhibit, but it is important to simplify and accelerate "exchange by experience" between uniform objects.

Categorization of the functional features object management with standpoint of the formalizations of the processes of acquisition of the knowledge.

For development of technologies of acquisition and issues of the knowledge about action in free-lance situations, it is necessary to produce the categorization a knowledgebase. The Knowledgebase can be divided into the following categories:
- universal, referring to all considered areas, objects and situations;
- problem-solving, which pertains to given class objects and problem-solving situations;
- specific, which are bound concretely with data by object and particularity of its operation.

Herewith-universal knowledge is circulated on all, object, using considered methodology or is found in a certain central node. This depends on accepted computer technology. The Problem-solving knowledge, in the manner of corresponding to a knowledgebase, is circulated on an object of one class. The Specific knowledge, therefore, is only one object in the computer.

The General can be knowledge about social-economic law, principle of the spreading of contamination, or another disaster. In ditto time this "knowledge", referred to as a fixed object, is a quotient. The same situation with knowledge, under discussion knowledgebase, are structurized in the form of the info logical models. Accordingly, models can be universal, problem solving and specific. In the structure of each models, there are also included simulation and other computing models, in the manner of computing procedures.

In general type, knowledge, including models, can be presented as quadruplets of the type:

M=<S,R,I,K>

Where:
S - a base of the simulation models;
R - a base of the rule-oriented rules, which is renewed as a result of analysis decision making in emergency situation;
I - an information base;
K - a base of the general knowledge.

After emergency situations have occurred, it is necessary to produce analysis of decisions taken and not taken, their consequence, production of the rules and writing the optimum decisions in the base of the rule-oriented rules, accordingly global or local (universal, problem-solving or specific). For shaping the rules base it is necessary to have participation of a knowledge engineer, though in most cases it is enough to have a specialized program of the extraction of the knowledge.

Data mining technology usage in emergency management

The key factor in emergency management is an operative taking of efficient decisions. However natural is the longing to improve the process of decision making, it quite often comes across on enormous volume and complex structure data, requiring processing in emergency situations.

Practically, the database executes the function to memories, access of the user to vault data provides only an extraction of a small part from prelimanary stored information in response to clearly assigned questions. Yet, when we have an enormous flow of information, we will get up the task greatly reasonable to use this information to extract hidden data knowledge for the reason to optimize control of the process of emergency management. This task cannot be solved by the power of only one person on the strength of gigantic volume of given economic inefficacy of such a decision. Besides, analyst results are not alwarys objective since people follow some considerations, a priori beliefs about the study subject that are reflected on the objectivity of results.

The methods of “data mining” allow a reduction of this problem. Using promoted analytical methods in the field of mining the knowledge from source, "damp" data, many organizations have increased profits, raised power, lessened expenses and enlarged client base. The methods already are actively used at analysis market, marketing, forecast of the stock quoting and other business-applications. But in the first place these methods today must interest the commercial enterprises, unfolding projects on base information vault given (Data Warehousing).

The correlations of the volume and speeds define the possible use of the artificial intelligence systems KDD (Knowledge Discovery in Databases) - a system of the extraction of the knowledge from database.

Using the systems KDD requires the known art of the director of the exploratory tasks since their decision must ultimately match logic with his intuitive analysis. The Key to successful using of the methods of KDD involves not only the choice of one or several algorithms KDD, but also the skill of the analyst. Data Mining does not exclude the need for the knowledge of specifics of the application domain and understanding of data or analytical methods.

Knowledge discovery in databases is an analytical process of the study of the large volume of information with attraction of the facilities of the automatic study given for the reason finding hidden in structure data or dependencies. It is expected to obtain full or partial absence of the a priori beliefs about nature of the hidden structures and dependencies. KDD includes the

preliminary comprehension and incomplete wording of the task (in term target variable), transformation given to available automated analysis format and their preprocessing, finding the facility of automatic study given (data mining) hidden structures or dependencies, approbation of the discovered models on new, not used for building of the models data and interpreting the person of the discovered models.

Data mining ("development given") - a study and finding "machine" (algorithm, facility of the artificial intelligence) in damp given hidden structures or dependencies, which
- earlier were not known,
- not trivial,
- practically useful,
- available to interpreting the person.

As a whole technology, data mining is defined by Gregory Piateckiy-Shapiro - one of the founders of this direction: data mining - a process of the finding in damp given earlier unknown, нетривиальных, practically useful and available interpreting the knowledge required for decision making in different spheres of human activity Any cognition presents itself for modeling. The Model - artificially created system, in which is reflected resemblance of the structure and functions with system-original. Exist two types of the models: предсказательные and descriptive. The First one set given with the known result for building of the models, which obviously predicts the results for the other set data, but the second describes the dependencies in existing data. The revealed model will not be able to pretend on absolute knowledge, but will give the analyst certain advantages to alternative statistical significant model.

The task of the model building can be divided into two important subranges. First, the task to categorize - referring the new object to some class from their ensemble on base already available, given about the other object of these classes. The other subrange form the tasks of the forecast of some unceasing numeric parameter.

Case study 1. An emergency management in flood hazards.

Recently in Russia and all over the world, there have been sharply increased losses from different disasters, in particular from high water and floods such as on river Lena and in other Russian regions. This report considers the possibility of the use of the achievements of scientific and other organization on basis of the system approach, mathematical modeling (including economic and social aspects), and integrations of other scientific and engineering decisions, could greatly reduce the losses from, or prevent, these disasterst. Amongst the organizations whose results are used in the development of the project are: The Institutes to Russian Academy of Sciences - Institute for system analysis, Institute of the water problems, Computing center, Institute of the problems of management, VNIIGMI-MCD of Rosgidromet, Faculty on surrounding ambience of the University Waterloo in Ontario (Canada) and Exploratory Center on floods in Great Britain (Flood Hazard Research Centre, Middlesex, UK).

The existing system of the measures and decision making appear, on glance of the authors, to suffer from the absence of systems approach, insufficient scientific investigations, lack of the different factors accounted, and not taking into account social-economic aspects.

Floods are one of the most serious natural disasters, and annually are occurring in many countries of the world. In spite of all undertaken preventive measures they are vastly overtaking, in terms of victims and material damage, such disastrous phenomena as earthquakes. In the year 1999 for example:
- of the total number of 130 large natural disasters (including earthquakes, storms, droughts and etc) that occurred this year, nearly half - 60 - were for floods;
- victims (perished) of floods (55360) far overtake earthquakes (24964);

- in terms of number of disasters, floods (60) are closely approached by only storms (47)

The countries most subject to floods are situated basically in southeast Asia (India, Indonesia, Philippines, China, Bangladesh, Nepal), and then in Latin America (Venezuela, Columbia, Peru), from they vastly lag behind the Africa (Sudan, is Extinguished).

From European countries, floods most often in Switzerland, Germany (Bavaria), and Austria. The number of victims in these countries is small, but material damage is compensated by a developed system of insurance.

The main reasons of the floods in most cases are driving rains, sea waves, sometimes destructions or breakout of the dams. The Floods basically strike the developing countries that are explained not only by their geographical position (the regions rainstorm, location territory at a rate of epidemic deaths and etc), but also their heavy economic position, preventing separation of the significant funding on undertaking corresponding preventive work.

Last year, for the first time, question about floods turned out to be in the public eye in the entire country. This is explained by not only the scale of the disasters, but also by statements of the president of the country and EMERCOM minister, and the lack of well-timed and necessary measures on protection of large populated points, in particular in some regions of Siberia from - follows specifically to emphasize - from annually reiterative large floods (before this let and smaller scale). As is well known, warning of exceeding situation or disaster dispenses usually are cheaper than removal of their negative consequence. What can be said about effieciency in cases such as the building of the defensive sandy dams, when flooding has already exceeded critical mark and a thousand of the constructions turned out to be under water?

Meantime, corresponding to models of possible disasters, scale and negative consequence for concrete river pool could greatly relieve the development of scientifically motivated systems of efficient action and buildings while avoiding dangerous disasters, that in any event greatly reduce costs, which this year practically carried the whole country.

The system approach is offered to planning and control water resource pool of the rivers: system hydrodynamic models of the processes - currents of water, spreading the contamination, economic - an accommodations production, co-ordinations interest branches, developments fish population, production to electric powers expert estimation restrictions of the depths for navigation. The simulation system calculation of the controller rules is considered in purpose of the rational satisfaction request water customers.

Case study 2. A Terrorism Crisis Management in Transport.

One of the very important problems for emergency management is to increase the capacity of their communities to survive and recover from terrorist attacks by building an enlarged set of risk-management decision support tools and procedures for standardized evaluation and mitigation of the consequences of a terrorist attack on critical transportation infrastructure. The project will emphasize (1) the use of a Geographic Information System to create a notional port city with air, rail and marine transportation facilities and demonstrate the notional relative proximity of critical infrastructure, (2) identification of hazard simulation and modeling tools to both superimpose damage footprints across critical infrastructure and demonstrate potential consequences to the community, and (3) demonstration and econometric model evaluation of alternative mitigation and causal chain intervention strategies that are proposed by various economies. To facilitate collaboration among a maximum number of economies, high bandwidth video teleconferencing with streaming video will be used to minimize transportation costs of participants and mutually demonstrate web-accessible mapping, simulation and modeling techniques currently used by various economies.

The task is to assemble a web-accessible toolbox of hazard models and decision support simulations with use of GIS notional port communities with critical infrastructure and cross-linked hazards.

It is very important to develop econometric models that can be used as decision-support tools in evaluating the relative merit of alternative strategies of mitigation, response and recovery from various types of terrorist attacks.

The next feature for this case study is collaboration over a high-bandwidth video-teleconference system.

As an overall objective, analysis tools and procedures would be exportable and adaptable for mutual use by any individual economy in assessing their own economy's vulnerabilities, conducting their own terrorist attack consequence mitigation program and increasing the abilities of their own communities to survive and recover from terrorist attacks. A list would also be compiled of sources for GIS hazard mapping products and video-telecommunication sites among the various economies, encouraging mutual assistance and continued collaboration.

Conclusion

In the report the part of problems arising at practical mining, tracking, actualization and usage of the information from computer intelligence systems is affected. Behind frameworks of a material there were a number of other problems, such as a filtration of input information, principles and methods of activity with the inexact information, interaction of the initial and aggregated information. The statement of these problems is connected, first of all, to practical activity with intelligence systems. Many from these problems arise from concrete experience and hardly can be put beforehand. The solution of these problems is very important and allows to be advanced to successful usage of intelligence systems for decision-making in composite situations.

As display researches put within the framework of creation universal EMS a problem, have not the shelf solutions on the majority of the considered problems. The existing methodologies of designing and creation of the integrated intelligence systems are calculated on much more formalized objects, which are not unique and envision duplicating.

Conclusion about necessity of constant methodological tracking of development of the project, acceptance both implementation of the "soft" solutions and floppy approaches from here follows, which will allow to acceptance of new technological and system solutions appearing during existence of the project.

For usage of extended possibilities of data management systems, means of the analysis and submission of the information, inclusion in program systems of the statistical analysis, classification and recognition, methods of an artificial intelligence for the analysis and interpretation of results of processing is necessary. There is basis to expect that the further development of geo information systems will occur just in this direction.

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