DOI: 10.37943/AITU.2022.20.82.006

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INTELLECTUAL INFORMATION TECHNOLOGIES IN THE ACTIVITIES OF THE EMERGENCY RESCUE SERVICE

Abstract: The paper considers the features of the use of intelligent information technologies in the process of the emergency rescue service of the enterprise. To improve the efficiency of the rescue services, it is necessary to carry out strategic planning and management, which would be designed to prevent the occurrence of an emergency (emergency). Effective subsystems of emergency proactive planning should not only predict the occurrence of possible emergencies, but also provide for appropriate preventive measures, and emphasis should be placed on eliminating the underlying causes, not the emerging consequences. The change of modes in the event of an emergency can be effectively implemented through the deployment of a technologically secured situational center. Decisions in emergency situations are made in various operational situations, including crisis, and in extremely limited time. Nevertheless, they must be taken in a timely manner, be as reasonable as possible, and ensure the fullest and most effective use of available opportunities. Decision-making processes can be based on the personal experience of participants in the management process. As you carry out your professional activity, experience is formed, which subsequently allows you to perform some tasks much faster and more efficiently. To gain experience, it is proposed to use a knowledge management system based on ontology. In order to ensure maximum awareness of the management of the situation, it is proposed to use the expert system of the situation center. (ES SC) The ES of the situational center of the authorities can significantly improve the efficiency of management processes and provides information support for strategic and tactical management decision-making. The ES should implement tools for a comprehensive and operational assessment of the state of the management object and situational analysis of the identified problems.

Keywords: Emergency situation, knowledge management, emergency rescue service, situation center, expert systems

Scientific Journal of Astana IT University
ISSN (P): 2707-9031 ISSN (E): 2707-904X
VOLUME 9, MARCH 2022

Introduction

Natural and man-made risks are the most important factors determining the quality of life. The degree of technogenic and natural risk of an emergency depends on three factors: the probability of an emergency, the severity of its consequences, and the level of human security provided by emergency services in the event of an emergency. The probability of man-made emergencies and the severity of their consequences largely depend on the specific characteristics of industrial facilities, it is especially high for mining enterprises.

The main features of the functioning of control systems in emergency situations are that the problem (emergency) develops unexpectedly, suddenly. When it arises, the management system faces tasks that are not typical of the stationary mode of operation of the organization and its past experience. Countermeasures should be taken urgently, but the usual order of activity does not allow this to be done for the following reasons.

The existing work plans do not correspond to the new situation: new tasks arise; information that should be studied and analyzed comes in an intensive stream. In these conditions, panic may occur.

The relevance of the work is due to the fact that the combination of a project approach and intelligent information technologies can facilitate the task of data collection and processing and, accordingly, minimize risks and consequences. Currently, modern means and methods of obtaining video and radar data are used to analyze potentially hazardous areas. The data is used to monitor changes in surfaces, objects and technological processes, as well as to plan emergency and repair and restoration work. The analysis of these data, as a rule, is carried out poorly. There are no models and description algorithms. For the first time, a multilevel structure for collecting and processing heterogeneous data on potentially hazardous industrial facilities and territories is proposed, which includes data from warning systems, aerial photography, and video surveillance.

Literature review and problem statement

A lot of research by scientists Kulba V.V., Krymsky V.G., Yusupov I.Yu., Yamalov I.U., etc. has been devoted to issues of management in emergency situations and information support of the emergency response process [1,2]. Yusupova N.I., Enikeeva K.R., Rizvanov D.A., Shakhmametova G.R. are studying the ways of using intelligent technologies in the field of emergency prevention and response processes [3,4]. Shaptala V.G., Radoutsky V.Yu. are engaged in the application of mathematical models in the field of emergency forecasting. The works of Latkin M.A., Stepanova M.N., Vasyutkin are also devoted to mathematical modeling The latter, in particular, consider the schemes of construction and options for organizing events in the event of an emergency in educational institutions. Among foreign scientists, we can mention R. Cook, L. Gossen, S. Guaro, V. Marshall. Despite the ever-growing interest in this area, a number of issues remain relevant and need to be addressed. In addition, the works are divided into two categories: the first ones investigate the theory of the occurrence of emergencies, build mathematical models of situations, and the second ones pay attention to the organizational component. So, most of the studies concern the issues of emergency response, i.e. management after the event has already occurred. Accordingly, in such cases, they proceed from what means and methods are available to the rescue services. To improve the efficiency of the rescue services, it is necessary to carry out strategic planning and management, which would be designed to prevent the occurrence of emergencies. This area of management is quite complex, the environment around it is constantly changing, therefore, modern information technologies are necessary for the most effective solution to emerging problems.

Purpose and objectives of the study

The purpose of the work is to describe the principles of using intelligent information technologies to analyze the operation of potentially dangerous objects. As the main tasks, we will highlight:

– emergency service management modes based on the project approach;

– analysis of the situation center infrastructure as the central data collection apparatus;

– definition of logical interaction when working with the information system of the emergency rescue service;

– formation of ontology as the basis of the knowledge management system of the expert system of the emergency rescue service.

Materials and methods

When allocating resources and organizing enterprise management, as a rule, a structural or functional approach is used. However, recently the project approach has been showing its effectiveness. In general, project management is an approach to the distribution of labor and material resources, as well as the interaction of all stakeholders within the framework of common work. Projects allow you to organize business processes that are not carried out within the normal activities of the enterprise. The project team can include both employees of the enterprise and external specialists. Projects are characterized by the presence of three restrictions: cost, content, time. All requirements and stages of the project are coordinated in accordance with these restrictions. When planning a project, it is necessary to foresee the occurrence of risks. A risk is an event that may affect one of the goals of the project. Managers calculate risks before the start of the project.

For the mining industry, as a large industrial enterprise, as a rule, it is impossible to implement just one project. Projects are implemented simultaneously and can use the same resources. The projects being implemented in this case are called the project field. In the mining enterprise, the projects are mainly large-scale in the technical sphere, i.e. they involve significant financial investments.

Managing a set of projects requires a combination of many methods and approaches. One of the management methods is controlling. There are 4 main stages in the implementation of projects at a mining enterprise [2].

At the first stage, the main goals and objectives of the project are formulated and risks are identified. In addition, the analysis of previously completed projects, their effectiveness, and the deviation of the actual implementation from the plan is carried out. It also prescribes all the regulations for the implementation of all business processes of the project.

At the second stage, the projects are analyzed from the point of view of their compliance with the principal goals of the enterprise. Here, the planning of project indicators is carried out with the indication of responsible persons.

At the third stage, draft reports are being developed, which will reflect planned and actual indicators in terms of time and costs for each stage of work.

At the fourth stage, a document management system is being developed that will allow monitoring the performance of indicators.

The project approach to all projects, including the prevention and liquidation of emergency situations, allows you to structure and organize centralized control over the allocation of resources and the implementation of all necessary stages of work.

Let us consider in more detail the nature of the activities of emergency services.

Depending on the specifics, the company organizes its own emergency rescue units or prescribes the procedure for attracting external services in accordance with the accepted internal regulations. The emergency rescue service is created to solve the following tasks:

Scientific Journal of Astana IT University
ISSN (P): 2707-9031 ISSN (E): 2707-904X
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– organization and conduct of rescue operations to prevent and eliminate emergencies;

– maintenance of documentation on the issues of emergency rescue operations;

– creation and development of the material base for emergency response, provision of employees with the necessary materials, overalls and personal protective equipment;

– constant study of surveillance objects and replenishment of the database of potentially dangerous objects.

Effective subsystems of emergency proactive planning should not only predict the occurrence of possible emergencies, but also provide for appropriate preventive measures, and emphasis should be placed on eliminating the underlying causes, not the emerging consequences. This is the first mode of operation of such systems.

The first mode consists in the implementation of a preventive plan, which should be flexible enough so that, if necessary, a specific action program can be built on its basis, including urgent measures for rescue and emergency work. Such a plan should include an analysis of activities, while no area should be left without attention. The plan defines the needs for personnel, areas where victims can be taken, the availability of food and possible bottlenecks in the logistics system. The value of such a plan at the time of an emergency is that it will minimize the time for collecting information and making the necessary operational decisions.

The second mode – high alert – is characterized by the emergence of information about signs of a potential emergency threat. The tasks of the emergency management system in this mode are the development and implementation of detailed action plans to prevent or mitigate the consequences of an emergency on the basis of pre-prepared scenarios of its development and response actions. The management implements methods of proactive detection of the occurrence and signs of the development of emergencies and rapid response to a changing emergency situation.

Predicting the possibility of an emergency and preventive planning are based on a regular assessment of trends in the development of the current situation, as well as the resources needed to improve it, stabilize and reduce the severity of the consequences of an emergency.

The third mode – emergency – is characterized by circumstances, the totality of which, in accordance with existing regulations, is defined as an emergency situation.

The tasks of management in this mode are operational actions to protect objects of various types from damaging factors, carrying out rescue and other urgent work.

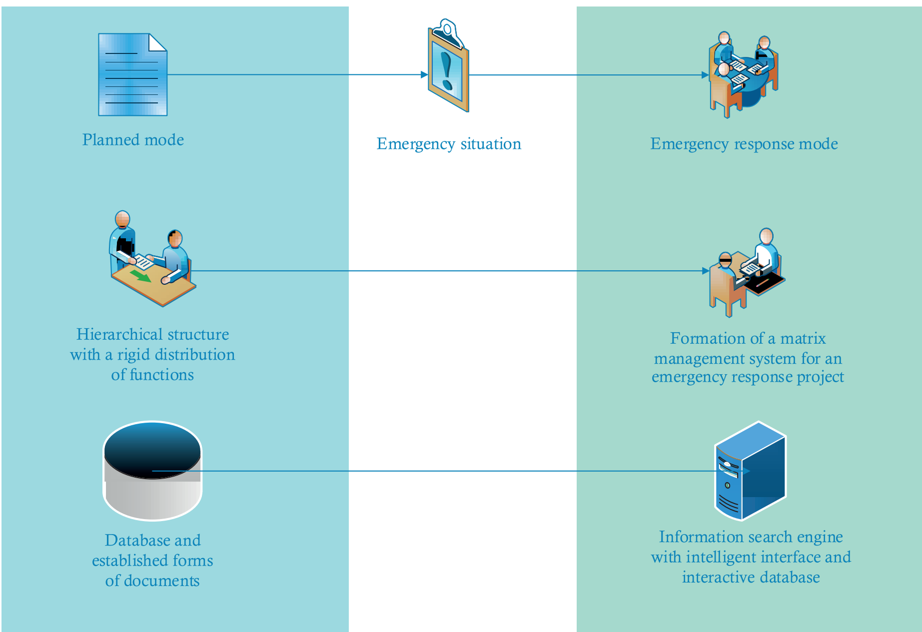

Figure 1. The scheme of changing modes in the event of an emergency

The practice of emergency response shows that the most difficult from any point of view is the initial period of occurrence of an emergency. The lack of reliable information about the situation serves as a breeding ground for the emergence and spread of various, as a rule, a very wide range of rumors; assessments, often polar, claiming to be reliable. The assessments formed during this period are very difficult to correct, reliable competent information is not perceived. The change of opinions and attitudes that developed in the initial period due to the lack of verified information is achieved only by systematic purposeful efforts; professional reliable knowledge is perceived with prejudice. In order to form an adequate understanding of emergencies and working conditions, the use of open information about the problem that has arisen should be most widely practiced.

It should be borne in mind that in an emergency situation, the formation of a pattern of actions is of great importance. This is especially important when the precautions taken indicate the extremity of the situation, which affects the perception and imagination of the participants in the work, leads to an increase in tension and anxiety. A pattern of actions allows you to overcome an unreasonable (and sometimes justified) feeling of anxiety.

The change of modes in the event of an emergency can be effectively implemented through the deployment of a technologically secured situation center (SC).

The situation center is an information and technical complex designed to collect, store, analyze and process information in order to carry out full-fledged monitoring of situations. Based on the incoming data flow, important operational decisions are made in the situational (dispatch) center and possible scenarios are modeled.

The software and technical levels contain the appropriate software necessary for the implementation of the tasks and functions set at the upper levels. The levels include the following mandatory components [5]:

– measuring (sensory environment);
– information (situational or simulation) model of the environment;
– information support environment;
– hardware support environment;
– visualization environment;
– operational staff.

The measuring (or sensory) environment of the SC is understood as a set of hardware and software tools used to obtain information about the state of the problem environment. These can be antenna systems, communication channels, video and audio transmissions, sensors, etc. The main task of the measuring environment is to ensure the adequacy of the information model of the SC of the real situation.

An informational (situational or simulation) model of the environment is a set of at least the following components: a thematic component that defines the set of simulated concepts of the problem environment; a spatial component that defines spatial relationships between model objects; a graphical component that defines the mapping of model objects into a set of graphical symbols (graphic primitives).

The information support environment is a set of programs and information flows that ensure the functioning of the information model and the SC visualization environment. First of all, this includes monitoring systems, expert systems and simulation systems. A characteristic feature of any SC is the binding of the situational model to the terrain, therefore, geoinformation systems may be included in the composition. Forecasting systems based on neural networks and genetic algorithms can be used to assess the development of situations. The effectiveness of graphical and textual representation can be achieved through the use of fractal and cognitive graphics.

Scientific Journal of Astana IT University
ISSN (P): 2707-9031 ISSN (E): 2707-904X
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The hardware support environment is a set of technical computing tools that ensure the functioning of the SC information support environment: Computers, office equipment, network equipment, etc.

The visualization environment is a set of screens for collective and individual use, providing an information and command interface between a human operator and the hardware and software environment of the SC.

The operational staff is a team of specialists who have their own internal organizational structure. The purpose of the operational staff is to provide a solution to the set of regular tasks of the SC based on the analysis of the information model of the real-world situation formed by the hardware and software environment of the system.

Situational centers allow solving the following tasks at the preliminary stage, i.e. in the first mode:

– Monitoring the status of tasks within the competence of the republican and regional levels, state corporations and large enterprises;
– Providing information support to managers;
– Analysis, modeling and forecasting of the state of the control object;
– Development and controlling of team solutions for strategic planning and operational dispatch management of complex situations;
– Effective management of a team of experts in the process of developing and implementing management decisions;
– Modeling, forecasting and optimization of the consequences of management decisions based on the use of information and analytical technologies;
– Analysis and controlling of the financial condition of the management object.

Information base for the situation center

Data collection systems from hard-to-reach objects allow you to organize and automate the process of collecting information from a geographically distributed network of objects using various communication channels. A location determination system usually consists of a coordinate determination subsystem, a data transmission subsystem, and a data management and processing subsystem. Positioning of mobile and hard-to-reach objects can be carried out using the GPS global positioning system or the GLONASS satellite system.

The geoinformation subsystem of the situational center (GIS SC) is an ordered system for analyzing geospatial data. The system contains the most detailed cartographic substrate, industry, regional, urban data, and has the ability to access thematic layers of spatial data and enter new data. The composition of the GIS SC depends on the purpose of the situation center and the tasks for which it is created.

The GIS structure, as a rule, includes four mandatory subsystems:

1. Data entry, providing input and/or processing of spatial data obtained from maps, remote sensing materials, etc.

2. Storage and search, which allows you to quickly obtain data for appropriate analysis, update and correct them.

3. Processing and analysis, which makes it possible to evaluate parameters, solve computational and analytical problems.

4. Presentation (output) of data in various forms (maps, tables, images, block diagrams, digital terrain models, etc.).

In recent years, the development and research of data transmission systems using satellite and other communication channels have been carried out by various companies in a number of countries around the world. The main manufacturers of modern SPD equipment are Cisco Systems, 3COM, Allied Telesis, D-Link. However, most of the developments of these well-known companies are focused on the use of specific types of channels without their integration. Centralized processing of heterogeneous information is not adequately provided, software and hardware complexes and control centers are not integrated into a single information space. There are also no complexes on the market to ensure the integration of data coming to mobile monitoring centers from unmanned aerial vehicles (UAVs). The extensive capabilities of UAVs to monitor sufficiently large areas from the air are mainly used autonomously.

Simulation of the evacuation process

The most important task of the situation center is to prevent emergencies by analyzing incoming data and modeling the development of the situation on their basis. In addition, on the basis of this information, scenarios of the behavior of all involved persons in the event of an emergency are formed. The main way to save people in case of an emergency is evacuation. Its competent organization allows you to minimize losses and reduce them to zero. Optimization of the evacuation route is an important task, the implementation of which allows you to minimize or prevent losses. Description of this situation using agent modeling is one of the ways that will help to understand and predict how and when to carry out an evacuation. In agent-based modeling, the system is modeled as a set of autonomous decision-making entities. Each agent individually assesses their situation and makes decisions based on a set of rules.

So, let's give a set of some points in three-dimensional space, it is necessary to build connections between them (a set of edges), thanks to which it is possible to analyze movements on the modeling object. It is proposed to use Delaunay triangulation to construct edges. The Delaunay triangulation is a division into triangles for a certain set of points on the plane (in a generalized form in N-dimensional space), in which for any triangle of the triangulation all the original points, except those that are its vertices, lie outside the circle described around the triangle (empty circle criterion).

This criterion is graphically depicted in Figure 2. To construct the Delaunay triangulation, an algorithm based on the sweeping line method was used.

The data structures used in the implementation of the algorithm include two types: point, and triangle. The point has two components: the x coordinate and the y coordinate. A triangle has two array-type components, one for writing three pointers to its three vertices, and the other for writing pointers to its three adjacent triangles with common edges.

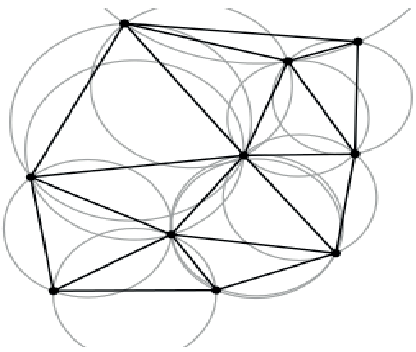

Figure 2. Empty circle criterion

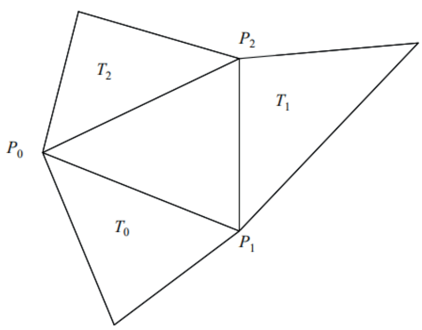

Figure 3. Illustration of triangles

So, let's give a list of P points $P_i = (x_i, y_i, z_i)$, where $x_i, y_i, z_i \in R$ of a three-dimensional space (vertices) forming some surface framework. The Delaunay triangulation algorithm will be built according to the method, which consists in the following:

1. The list of vertices P is sorted by one of the coordinates (for example, the coordinate "x") in such a way that $x_i \leqslant x_{i+1}$ for all elements of the list P

Scientific Journal of Astana IT University
ISSN (P): 2707-9031 ISSN (E): 2707-904X
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2. Using the first three points P_1, P_2 *and* P_3, the first triangle of the triangulation is constructed $P_1P_2P_3$, adding edges $E_1 = (P_1,P_2)$, $E_2 = (P_2,P_3)$ and $E_3 = (P_1,P_3)$ into set of edges E (figure 4).

3. The third and fourth steps are repeated for each vertex P_i, $4 \leqslant i \leqslant n$, where n – number of vertices. Point P_i, adding to the set E edge (P_i,P_{n1}), ..., (P_i,P_{nk}), which connect P_i with visible vertices already processed (vertex A is called visible from vertex B if, when constructing an edge (A, B), this edge does not intersect other edges and does not contain other vertices). Thus, triangles will be constructed $P_iP_{n1}P_{n2}$, $P_iP_{n2}P_{n3}$, ..., $P_iP_{nk-1}P_{nk}$.

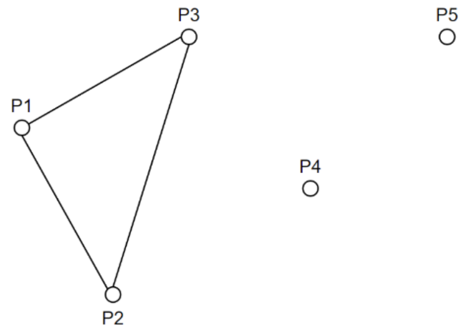

Figure 4. The first triangle of the triangulation

After constructing the triangles, it is necessary to check the quadrilaterals generated by these constructions for the Delaunay condition [6], in Figure 5, for example, such a quadrilateral is $P_1P_2P_4P_3$ with diagonal P_2P_3. For triangulation, the Delaunay condition can be described as follows: the sum of the minimum angles of all triangles among all possible triangulations must be maximal. One of the checks of the Delaunay condition is a check through the equation of a circumscribed circle. Equation of a circle passing through points $P_1(x_1,y_1)$, $P_2(x_2,y_2)$, $P_3(x_3,y_3)$, can be written as $(x^2 + y^2)\,a - xb + yc - d = 0$, where

$$a = \begin{vmatrix} x_1 & y_1 & 1 \\ x_2 & y_2 & 1 \\ x_3 & y_3 & 1 \end{vmatrix}, b = \begin{vmatrix} x_1^2 + y_1^2 & y_1 & 1 \\ x_2^2 + y_2^2 & y_2 & 1 \\ x_3^2 + y_3^2 & y_3 & 1 \end{vmatrix}, c = \begin{vmatrix} x_1^2 + y_1^2 & x_1 & 1 \\ x_2^2 + y_2^2 & x_2 & 1 \\ x_3^2 + y_3^2 & x_3 & 1 \end{vmatrix},$$

$$d = \begin{vmatrix} x_1^2 + y_1^2 & x_1 & y_1 \\ x_2^2 + y_2^2 & x_2 & y_2 \\ x_3^2 + y_3^2 & x_3 & y_3 \end{vmatrix}.$$

Then the Delaunay condition for any given triangle $P_1P_2P_3$ will be executed only when for any point $P_0(x_0, y_0)$ triangulation will be right $(a(x_0^2 + y_0^2) - bx_0 + cy_0 - d)\, sgn(a) \geq 0$, where sgn(a) – a function that returns +1 if the value of a is non-negative, and returns -1 otherwise. The fulfillment of the condition means that the point does not fall inside the circle described around the triangle $P_1P_2P_3$.

Consider the triangulation in Figure 6. The quadrilateral $P_1P_2P_4P_3$ there can be two triangulations: with triangles $P_1P_2P_3$, $P_2P_3P_4$ and triangles $P_1P_3P_4$, $P_1P_4P_2$. Thus, for all generated quadrilaterals, the Delaunay condition is checked and the set of triangles that satisfies the Delaunay condition is constructed.

4. The last step of processing the vertex P_i is a recursive check for the Delaunay condition of those quadrilaterals that are associated with previously modified quadrilaterals, if any (Figure 5). For example, in Figure 5, when processing a vertex P_7 there is a realignment in the quadrilateral $P_7P_3P_4P_6$, edge P_3P_6 is deleted due to non-compliance with the Delaunay condition

of triangles $P_3P_4P_6$ and $P_3P_7P_6$ and an edge P_4P_7 is added. As a result, new quadrilaterals will be formed $P_2P_3P_7P_4$ and $P_4P_7P_6P_5$. They also need to check for the Delaunay condition.

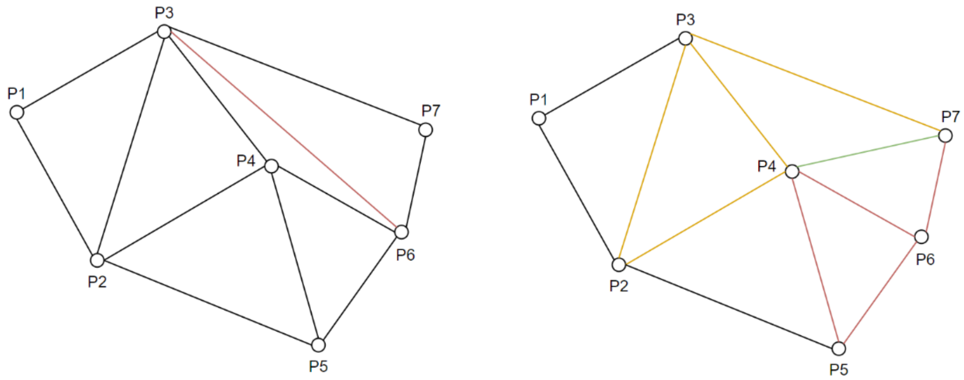

Figure 5. Triangle rearrangement and recursive verification

As a result of constructing the Delaunay triangulation [6], a connected object graph is obtained, that is, an object graph with one connectivity component, which guarantees at least one path between any two vertices of the graph. The resulting graph of the object is stored as an incident list $L = (P_i, P_j)$, where P_i and P_j – vertices of the graph, a (P_i, P_j) – a pair of vertices connected by an edge.

The vertices of the graph of the object set the coordinates of the surface of some area. The vertices of the graph are connected by edges. Edges have weights: length, which shows how much distance will be overcome when moving from one vertex to another. The distance between two vertices P_i and P_j in the simplest case is proposed to be calculated as the norm of a vector in Euclidean space as follows:

$$d = \sqrt{(x_i - x_j)^2 + (y_i - y_j)^2 + (z_i - z_j)^2}$$

The constructed graph allows you to analyze the paths between the specified points of the object. In particular, the most important task associated with evacuation is to find the shortest paths.

Decision making

Within the framework of the activities of any enterprise, decision-making tasks constantly arise. This also applies to the emergency rescue service, where people's lives may depend on the efficiency and correctness of decisions [7, 8].

Decisions in emergency situations are made in various operational situations, including crisis, and in extremely limited time. Nevertheless, they must be taken in a timely manner, be as reasonable as possible, and ensure the fullest and most effective use of available opportunities.

This requires a clear understanding by the management of the goals and objectives of the operation, a comprehensive and objective assessment of the situation, and competence.

The main components of this complex process are: the collection and preparation of initial data, the construction of an emergency development model, the formulation (adoption) of a decision by the head, the specification and detail of the decision in the plan of operation, bringing this decision to the executors, as well as the organization, operational management, and control of its implementation.

Centralized management allows management to coordinate the activities of performers in a short time and in the best possible way, effectively use equipment and limited resources, quickly transfer efforts from one direction to another, control any situation and, if necessary, take any initiative in management.

Scientific Journal of Astana IT University
ISSN (P): 2707-9031 ISSN (E): 2707-904X
VOLUME 9, MARCH 2022

The greatest degree of centralization of management is advisable primarily when solving complex tasks in crisis situations. At the same time, the initiative of employees is directed mainly to ensure that with the least losses and expenditure of material resources in the shortest possible time to complete the tasks set.

Under normal conditions, the combination of centralization and decentralization is reflected in the preliminary distribution of management functions, but in an emergency, it is almost impossible to do this. In these conditions, the distribution of functions occurs almost constantly, which requires, in addition to a well-developed communication system and an information system for the prompt coordination of decisions, the manifestation of a reasonable initiative.

The main governing body is the headquarters. Based on the decisions taken by the head, he unites and directs the efforts of all management services to timely and complete fulfillment of the tasks set. The Headquarters not only plans and organizes the work of employees engaged in emergency response, but also determines the tasks and work procedure of special services and brigades, organizes information support and interaction of all interested subsystems.

After the task is delivered, the situation assessment stage begins. It provides for the study and analysis of factors and conditions affecting the achievement of the goal of the operation. The driver evaluates the emergency and predicts its development, taking into account the available forces and means that can be used to eliminate emergencies, time, reserves of various types, etc. The volume and degree of detail of the situation data when studying and analyzing them depend on the availability of time and the level of management. The higher the level of management, the wider the range of analyzed issues and the lower the degree of their detail.

When assessing the situation in an emergency zone, its physical, geographical and economic data are analyzed and evaluated, as well as information about people who have been exposed to danger, strategic and operational directions of emergency response, engineering equipment of the territory. Natural conditions are considered, taking into account their impact on the possible development of an emergency and possible methods of its elimination. The necessary data on significant elements of the situation are extracted and processed using metrological means and means of communication and automation. At the same time, the greatest attention is paid to increasing efficiency. Communication and electronic data processing equipment should be introduced into the technical means, appropriate software has been developed, which will significantly reduce the time for displaying a continuously changing situation, including in graphic form. This will allow the management to adequately perceive the available data and create effective conditions for a quick assessment of the current situation in the development of emergencies.

After identifying the essential elements of the situation, their interrelations, when assessing the situation, they begin to build and analyze an emergency model, depending on the specific type of description chosen (including mathematical), they determine the dimensions of the state space, describe the internal dynamics of the system and the meaningful connections between sets of objects, the probability distribution for random impacts. Since identification depends on the type of emergency description, which, in turn, is determined by how well the identification was carried out, the construction of an emergency model is usually an iterative process: first, a mathematical description is chosen, then it is modified depending on the identification results, which leads to a new description, and the process repeats. Based on the analysis of the constructed model, the required decisions are made.

Knowledge management within the expert system

Decision-making processes can be based on the personal experience of participants in the management process [9]. As you carry out your professional activity, experience is formed, which subsequently allows you to perform some tasks much faster and more efficiently.

This experience represents the intellectual capital of the enterprise. Modern companies and enterprises should strive to preserve knowledge in a formal form in order to use it in the future activities of the enterprise, even if a specific employee - the carrier of knowledge - ceases to work at the enterprise. Knowledge management is a systematic process of using and transferring information and knowledge that all employees of the enterprise will be able to use in the future. The knowledge management system in the enterprise has a set of functions:

- integration - providing centralized storage and extraction of knowledge, providing employees with access to this information, using knowledge in the processes of employee training, decision-making;
- distributive - ordering of knowledge, correlating it with certain categories, according to various criteria;
- analytical - selection of information resources, their analysis for the availability of knowledge, experience;
- security – ensuring the safety of knowledge and preventing information leakage.

The company's knowledge management system accumulates information from various sources and combines them into a single whole. Information is stored in various forms, it can be documents, databases and knowledge. Information from such a system is available to all employees of the enterprise and can be used for daily work. Corporate knowledge can be explicit – it is specific data, documents, tables, figures. They are transmitted in some formalized form. The second variant of knowledge is hidden knowledge. This is exactly the experience of a particular employee who, based on formal data, can draw a conclusion or make a certain decision. In the processes of emergency prevention and response, the experience of each employee who has previously been involved in such processes can be invaluable and allow to reduce time or other costs.

In order to ensure maximum awareness of the management of the situation, it is proposed to use the expert system of the situation center (ES SC).

The ES of the situational center of the authorities can significantly improve the efficiency of management processes and provides information support for strategic and tactical management decision-making [10]. The ES should implement tools for a comprehensive and operational assessment of the state of the management object and situational analysis of the identified problems.

Software development for a situation center always has a number of features. The first of them, which occurs even at the level of system concept development– is the complexity of formalization of functions and algorithmization of information tasks that implement these functions. In addition, within the framework of the development, it is necessary to take into account the need to create and further monitor the implementation of the regulations for solving tasks, taking into account the multilevel management structures, as well as the possibility of connecting various structures depending on the specific situation. Taking into account these features, when developing information and analytical support for the system, special attention should be paid to the development of analytical tools, automation of solving functional tasks and access to large volumes of heterogeneous information.

Within the framework of the ES, a single information resource is maintained, which is a knowledge base containing both structured (data series) and unstructured data (videos, news feeds, documents, cartographic information, etc.). In order to make informed decisions, information must be accumulated in the systems that will enable a comprehensive analysis of the situation. The sources of such information can be databases and data banks, information repositories of authorities, local governments, commercial enterprises and organizations, state statistics, state registration authorities, cadastre and cartography.

Scientific Journal of Astana IT University
ISSN (P): 2707-9031 ISSN (E): 2707-904X
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The knowledge base is based on their representation – ontology [11]. This is a formal representation describing the basic concepts of the subject area, from the relationship and interrelation. Ontology serves as the basis of the knowledge base about the subject area. The ontology allows to provide high efficiency of information search taking into account the context. The generation of individual knowledge by combining them from various sources - it can be databases, knowledge bases, employee experience - allows all employees of the enterprise or programs to use this knowledge.

Figure 6 shows the general scheme of the ontology of the subject area of emergency response and prevention. It contains concepts that relate to both the emergency mode and the normal mode. The ontology describes the processes of interaction between the main objects that are involved in the processes of emergency prevention and response. Geometric shapes are used to classify concepts. The way objects/concepts affect each other is indicated by arrows with captions [12].

Figure 7 shows a more detailed scheme of the ontology of emergency response processes.

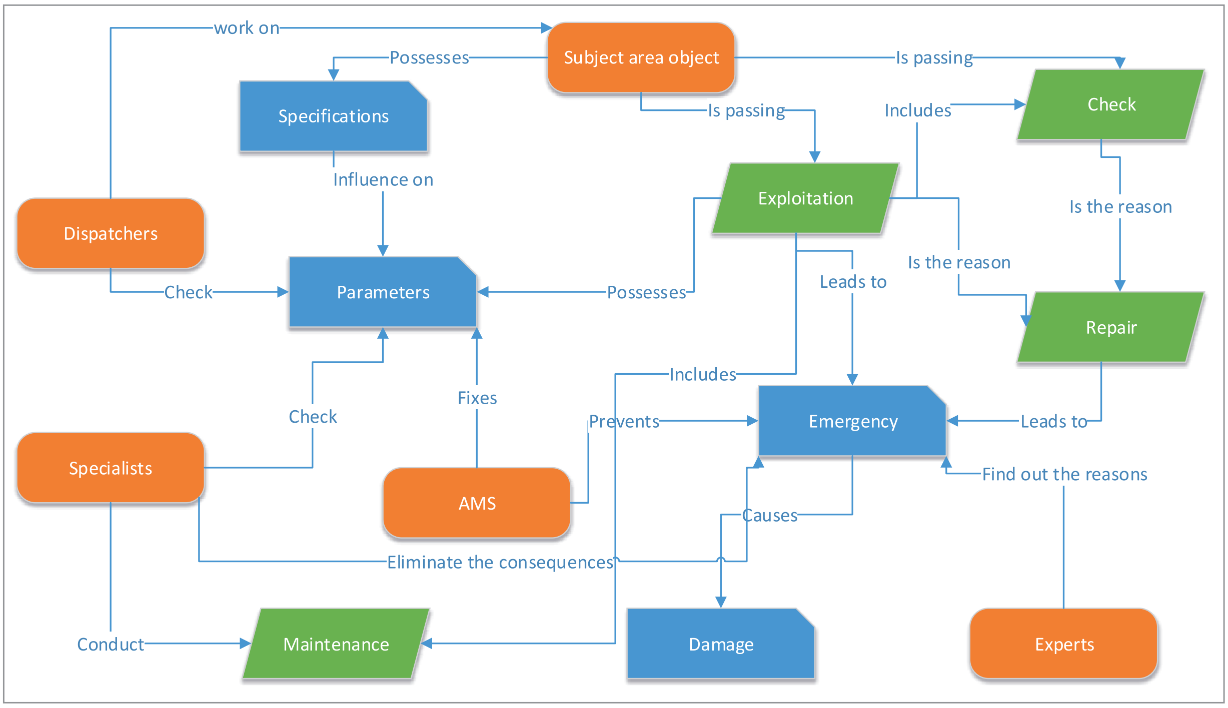

Figure 6. The general scheme of the ontology of knowledge representation about the subject area

The inference machine is responsible for analyzing the situation and processing information from the knowledge base. With the help of its tools, data on the state of controlled objects is analyzed in various aspects, based on the received complete and reliable information, the identified problems are analyzed, and risks are taken into account. ES allows you to conduct a scenario analysis of the development of the situation, taking into account the identified problems and risks, as well as to develop recommendations on the application of measures to fulfill the assigned management tasks. After making a management decision with the help of tools, it is possible to carry out plan-factor control of execution and evaluate the effectiveness and efficiency of the decision.

The outer shell of the EC SC is a system for presenting data and the results of the output machine. The interface of the expert system should provide convenient tools for extracting knowledge and visualizing it, because if an emergency has already occurred, every second is important to minimize its consequences.

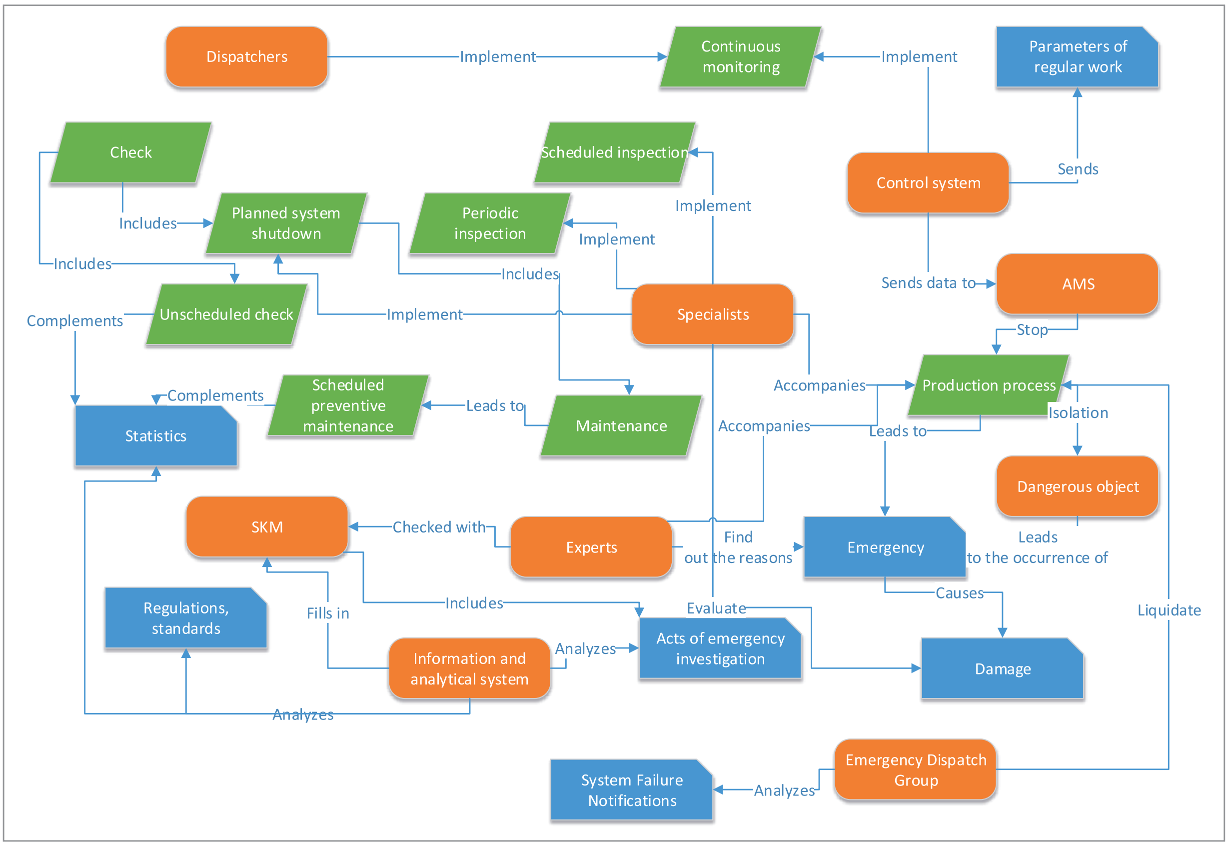

Figure 7. A detailed scheme of the ontology of knowledge representation about domain verification

Results

As a result of the work, the basic principles of the organization of project management of the emergency rescue service are considered. The levels of collecting and presenting information of the software and technical support of the emergency rescue service situational center are considered. Currently, the data is stored in the form of a point cloud and further enlarged surveying modules. The paper proposes a multi-level structure for collecting and storing data from different sources. The procedure for changing the modes of operation of the SC is presented. It is proposed to use the expert system of the situation center to provide data analysis to prevent and minimize the consequences of emergencies. The general and detailed ontologies of the data processing system for emergency prevention and response are presented.

Conclusion

Within the framework of the study, the goal defined at the beginning of the article was achieved. As a result, the modes of operation of the emergency rescue service were defined and described, the structure of the situational data collection center was developed. To ensure effective management and rational decision-making, an information system is needed that is configured to provide an emergency prevention and response system at the facility. It is advisable to build such a system based on a knowledge base that combines facts and expert experience of the company's employees.

Scientific Journal of Astana IT University
ISSN (P): 2707-9031 ISSN (E): 2707-904X
VOLUME 9, MARCH 2022

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