

Design Patterns for Emergency Management Processes

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Abstract—Natural or human made disasters have a significant negative impact on the environment. At the same time there is an extensive effort to support management and decision making in emergency situations by information technologies. Therefore the purpose of the paper is to propose a design patterns applicable in emergency management, enabling better analysis and design of emergency management processes and therefore easier development and deployment of information systems in the field of emergency management. It will be achieved by detailed analysis of existing emergency management legislation, contingency plans and information systems. The result is a set of design patterns focused at emergency management processes that enable easier design of emergency plans or development of new information system. These results will have a major impact on the development of new information systems as well as to more effective and faster solving of emergencies.

Keywords—Analysis and Design, Business Process Modeling Notation, Contingency Plans, Design Patterns, Emergency Management.

I. INTRODUCTION

EMERGENCY management, sometimes called disaster management, is a discipline of dealing with and avoiding risks [10]. It is a discipline that involves preparing for a disaster before it happens, disaster response (e.g. emergency evacuation or mass decontamination), as well as supporting and rebuilding the society after a natural or a human-caused disasters occurs. In general, any kind of emergency management is a continuous process in which all individuals, groups and communities manage hazards in an effort to avoid or ameliorate the impact of disasters resulting from the hazards. Actions taken depend in part on perceptions of risk of the subjects exposed [26]. Effective emergency management relies on thorough integration of emergency plans at all levels of government and non-government participants. Activities at each level (individual, group, community) affect the other levels. It is common to place the responsibility for governmental emergency management with the institutions for civil defense or within the conventional structure of the emergency services.

Process management [22], [24], [28] is a field of combining management and technology focused on aligning organizations with the wants and needs of clients. It is a complex management approach that promotes business effectiveness and efficiency while striving for innovation, flexibility, and integration with technology. Process Management attempts to improve processes continuously. It could therefore be described as a process optimization process.

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The basic term of process management is Business Process. It is a set of one or more linked procedures or activities, which are collectively executed to reach required business objectives or policy goals, normally within the context of an organizational structure defining functional roles and relationships [27]. These processes are critical to any organization as they generate revenue and often represent a significant proportion of costs. As a managerial approach, process management considers processes to be strategic assets of an organization that must be understood, managed, and improved to deliver products and services with added value to clients.

II. STATE OF THE ART

The organization of emergency management as well as the system of civil protection varies between the EU and US. However, there are still important commonalities. The nature of emergencies means that all levels of government (federal, state, regional, local) and all sectors of society are responsible for dealing with them [8], [19]. There generally exists a “bottom up” approach for requests for resources support that travel upward until appropriate resources are ensured and the incident stabilized. Thus, most emergency incidents are responded to at the local level. On the other hand, each country has different legislation, procedures, and obligatory documents to be followed within the emergency management process [11]. There also exists no universal terminology within emergency management, not only internationally but even within the agencies across all government levels. The paper is aimed on the Emergency Management in the Czech Republic.

A. Czech Emergency Management Legislation

With the foundation of the Czech Republic, The Czech National Council accepted The Constitution of the Czech Republic and published it in the statute book (the Czech collection of acts) under number 1/1993 Coll. The constitution deals with security problems on a very general level. It concerns the article 43, which modifies conditions of declaring war and sending armed forces beyond the Czech Republic. As it showed relatively soon, this law did not cover all needs in area of security of the Czech Republic. It was a reason to begin the works on preparation of constitutional law, which would solve these needs. This law was approved as constitutional law n. 110/1998 Coll. about security of the Czech Republic. These laws became the basis for the development of legislation aimed at the area of the Emergency Management.

Crisis management elements are codified in the Law No. 240/2000 Coll. [4] on crisis management and on modification of certain codes (Crisis Code), in latter wording. This law

determines the sphere of activity and competence of the State Bodies and the Territorial Self-government Bodies and rights and duties of legal and natural persons during the preparation to and the solution of emergency [4]. Based on this law, state of danger can be proclaimed to overcome unfavorable trends of development. State of Danger is the lowest of all States of Emergency that can be declared in the reaction to an abnormal circumstance by the Czech Republic Bodies. The Regional President, in Prague the Mayor of Prague capital, declares the State of Danger for the whole region or its part. It is possible to declare State of Danger for 30 days at most. Just the Regional President with government agreement can prolong this time.

Integrated Rescue System defined on Law No. 239/2000 Coll. [3], will be used in case of preparation to origin of an abnormal circumstance and in the necessity to carry out rescue and liquidation works by two or more Sections of the Integrated Rescue System at the same time. The Units of the basic Integrated Rescue System ensure a continuous emergency service for a receiving notification of the origin of the abnormal circumstance, its evaluation and immediate intervention in the place of abnormal circumstance. For these purposes, there is a deployment of forces and means all over the Czech Republic. Integrated Rescue System Bodies are obliged to follow the orders of Intervention Leader, eventually instructions of Municipal Mayor with extended competency, Regional President or Ministry of Interior as far as they are carrying out coordination of rescue and liquidation works.

B. Organizational Structure

To be able to manage the emergency circumstances effectively, it is necessary to build up a management on a hierarchical structure. The command must be clearly defined and kept because the Emergency Staff leader or Intervention Leader must have clear idea and competence for the solution of the emergency as a whole. This way of management is clearly legislatively confirmed and described in the organizational documents describing the solution of the emergency. The evident advantage of this approach is a clear responsibility for the commands issued by the Management Staff.

One of the basic bodies solving the emergency is a Security Council. The Regional Security Council has 10 members at most and the Regional President always nominates as its members the Secretary of Regional President, Regional Office Director, a member of the Police of the Czech Republic appointed by the Police Chief, Director of the Regional Fire Rescue Service, a member of the Army of the Czech Republic appointed by Army General Staff Chief of the Czech Republic, Director of Territorial Centre of the Medical Rescue Service and the regional staff member working in Regional Office who he dominates as Regional Security Council Secretary as well.

The next body is Emergency Staff. The members of the Regional Emergency Staff and determined municipality are the members of the competent Security Council and the members of permanent work group of the Emergency Staff.

The members of the permanent work group of the Emergency Staff are the Emergency Staff Secretary, the Regional Office Staff or Municipal Office of determined country and specialists with a regard to solved abnormal circumstance or emergency. Emergency Staff Leader decides according to the type of the abnormal circumstance or emergency. He will decide on work group or its part into alert and on summoning of the specialists. Emergency Staff Secretary is a Secretary of the corresponding Security Staff.

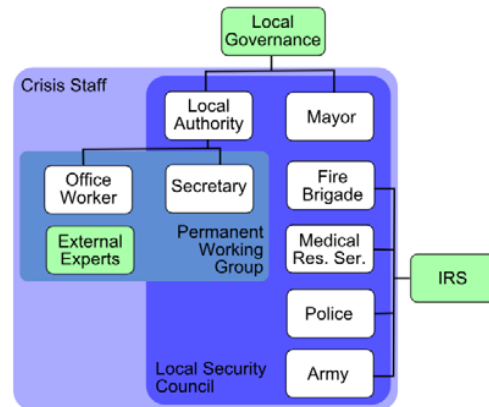


Fig. 1 Organizational Structure of Emergency Management

Intervention Leader [2], [15] is a Leader of Fire Protection Units, in principle a member of the Fire Rescue Service of the Czech Republic after his appearance in an intervention place. He takes over the intervention command, specifies the alarm degree Integrated Rescue System and its forces and means necessary for the intervention, he determines organization of the intervention place. In case of concentration of large amounts of forces or of large intervention, the Intervention Leader can establish staff, sections or sectors.

C. Contingency Plans

One of the Emergency Management features is a detail documentation that says how to behave in the individual emergencies. Contingency Plans belongs to the basic Emergency Management documents. Emergency plan contains a complex of arrangements and processes solving the emergency, so a summarization of the planning, methodical, informative documents used by decision, control and coordination action in the emergency [17].

The competent regional authorities process the Regional Emergency Plan. The processing is ensured by the Fire Rescue Staff. The Regional Emergency Plan is approved by the Regional President. The Regional Fire Rescue Staff discusses in Regional Safety Council scope and procedure of the processing of the emergency plan and the share of the Regional Authority, of the Regional Fire Rescue Staff and another subjects necessary for its processing. The emergency plan must contain activity, responsibility, and the tasks of the emergency plan processer. A part of each emergency plan is emergency risks enumeration and emergency security as well.

The emergency plan consists of basic and supplement parts.

The supplement part of the emergency plan, processed according to § 15 section 3 Legislation Decree No. 462/2000 Coll., contains planning, controlling, coordinating and another documentation processed for the solution of the emergency by the emergency plan processor or another subjects placed under contract [17].

III. APPROACHES AND METHODS

For the purpose of later processing it is appropriate to represent the processes in an appropriate manner. For this purpose, it is possible to use several graphical notations. Each of them seeks universal description of the process and takes into account certain specific features and characteristics of the processes.

Nowadays, there are many notations for representing processes. Flowchart, introduced by Frank Gilbreth, is one of the oldest. Another important way of illustrating processes is Control Data Flow Diagram. The methodologies like Structured Analysis and System Specification [7] and Modern Structured Analysis [29] are built up on this type of diagram. The Petri Nets [21] have also stable position among the processes notations. The concept was created by extending finite-state automaton and it is the most formal tool for process representation. None of the mentioned notations is widely used at present so the next chapter focuses on those that are more common nowadays: Unified Modeling Language and Business Process Management Notation.

A. Integration Definition Language

IDEF (Integration DEFinition language) is a software methodology and diagramming system developed by the US Department of Defense [23]. IDEF is used to produce a function model. A function model is a structured representation of the functions, activities or processes within the modeled system or subject area. IDEF is based on SADT (Structured Analysis and Design Technique), developed by Douglas T. Ross and SofTech, Inc. In its original form, IDEF0 includes both a definition of a graphical modeling language (syntax and semantics) and a description of an IDEF0 is a method designed to model the decisions, actions, and activities of an organization or system.

B. Event-driven Process Chains

Event-driven Process Chains (EPC) are based on connecting events and action to the sequences which collectively realize a business objective. Event is the precondition for the activity. New event (post condition) is generated when the activity is finished. It means that events define the beginning and end of each activity. EPC diagrams are used in SAP R/3 (ERP/WFM) and ARIS (BPR). Event-driven Process Chains diagram elements are [23]:

Activities are the basic building blocks that define what should be completed within the process execution.

Events specify situations before and/or after the activity are executed. It means that event may represent an output condition of the one activity and an input condition for the other activity at the same time.

Connectors are used to link together activities and events. This is a way the flow of control is defined. EPC uses the following three types of connectors: (AND), (OR) and XOR (exclusive OR).

C. Unified Modeling Language

Unified Modeling Language (UML) is a standardized modeling language used in the field of software engineering. The standard was created and is managed by the Object Management Group. UML includes a set of graphical notation techniques to create visual models of software systems.

Two diagrams are especially suitable for process modeling [1]. One of them is Use Case Diagram, which shows the functionality provided by the system in terms of actors, their goals represented as use cases. Then it depicts all the relations among those use cases. The other is Activity Diagram. It represents the business and operational step-by-step workflows of components in a system. An activity diagram shows the overall flow of control.

D. Eriksson-Penker Business Extensions

The Eriksson-Penker Business Extensions [9], [18] are intended as a basic framework for business modeling. Using these extensions, the business architects may add stereotypes and properties to the UML in order to suit their particular situation. The Eriksson-Penker extensions achieve process representation in UML by stereotyping an activity (from a UML activity diagram) to a <<process>>. In this approach, a process takes input resources from the left-hand side and outputs resources on the right-hand side.

E. Business Process Modeling Notation

Business Process Modeling Notation (BPMN) [22], [25] is a standard developed by the Business Process Management Initiative (BPMI). The primary goal of the BPMN effort was to provide a notation that is readily understandable by all business users, from the business analysts that create the initial drafts of the processes, to the technical developers responsible for implementing the technology that will perform those processes, and finally also the business people who will manage and monitor those processes. This way, BPMN creates a standardized bridge over the gap between the business process design and process implementation.

BPMN defines a Business Process Diagram (BPD), which is made up of a set of graphical elements. These elements enable easy development of simple diagrams that will look familiar to most business analysts [20]. The modeling of business processes often starts with capturing High Level Processes and then drilling down to lower levels of detail within separate Lower Level Process diagrams [25].

IV. PROPOSAL OF DESIGN PATTERNS

Proposal of Design Patterns is divided into four basic steps. First of all user roles are identified. Then the basics emergency processes in the area of leakage of dangerous substance are described in detailed and connected within identified user roles. The last step is definition of universal Design Patterns

by means of business process management notation.

A. Identification of User Roles

The first step of the creating design patterns is to identify user roles. It is necessary to follow regulations of the Ministry of Interior that regulates uniform rules of Emergency Staff organizational structure in regions and communities, putting it into standby, keeping records and some other details. The basic component of the Emergency Staff is a standing working group. Managers of the permanent Working Group are the Secretary of the Emergency Staff, the Head of the Permanent Working Group and the Head of expert groups. According to the model action plan of the Ministry of Interior describing an accident caused by a leak of hazardous substances, the following expert groups and their responsibilities have been determined [16]:

The Expert Group of Interaction and Communication – responsible for cooperation and collaboration with the operational centers of basic IRS, notifying of public authorities and the IRS about the situation, actions taken and the current changes.

The Expert Group of Military Logistics – working to standardize requirements for: the number of the IRS units deployed (especially external), all the necessary material and technical support (including safe food supply), accommodation and health services.

The Expert Group of Situation Analysis and Planning – responsible for analysis of the specific incident and prognosis of its further development, evaluation of efficiency of crisis and emergency plans, creation, management and use of maps and graphical illustration of the incident.

The Expert Group of Deploying Forces and Resources – responsible for centralizing information on interventions by commanders of intervention through the operational centers, evaluation of the effectiveness of interventions, conducting of surveys for the deployment of the Integrated Rescue System and other forces and resources.

The Civil Protection Expert Group – responsible for public warnings and information support, providing shelter, organizing of decontamination and identification of hazardous areas, medical support, registration of missing persons, identification and burial of the dead, protection of farm animals, protection of water resources, protection of cultural monuments, and other protective measures.

Emergency Staff is a working body governed by a county governor or mayor who gathers the staff. The staff's purpose is to respond to emergencies and mitigate their consequences. This also includes situations of national emergency declared in order to secure the defense of the Czech Republic and during the state of war or while coordinating rescue and relief work by the county governor or mayor with extended powers in emergency response. The Emergency Staff is gathered under the direction of the Emergency Staff, which also determine the time and place of their initial joint meeting. A part of the Emergency Staff mentioned above is the permanent working group, which consists of the village mayor or governor and representatives of different components of the IRS. These

representatives are primarily from the Police, Fire and Rescue Service, ambulance services or the Army of the Czech Republic.

Other important user roles are the operator of KOPIS, which is a Czech acronym for Operational Centre, and the Head of intervention. The operator of KOPIS receives direct information about the emergency that has just occurred. The operator of Fire Registration Office or the command centre receives a report on the event with all the necessary oversight. The operator has to find out the maximum of information from the caller, namely: the address of event, type of incident (fire, natural disaster or other emergency), details of events that the units intervening will require – e.g., danger to persons, their number and character of the building in which the event occurred, what other risks are there – name of the person reporting the event, their phone number and address (or place) where they are calling from. Then the operator informs the IRS and if the situation is of a larger extent, he or she informs the mayor. Another key role is the Head of intervention. The Head of intervention manages activities of the intervention units and other entities whose cooperation is required on the intervention site. He or she determines the management structure on the intervention site. In the case of a complex intervention requiring the coordination of rescue and relief work with other components of the IRS site and outside intervention, the Head of intervention can request a dispatch of a local Emergency Staff through operational and information centre of IRS and to ask for the coordination of emergency relief work.

Based on the analysis of user roles, it is possible to identify key user roles participating on the on the process of a response to emergency on the Emergency Staff level. These roles are:

- *Emergency Staff Leader;*
- *Emergency Staff Member;*
 - *Permanent Working Group* (Emergency Staff Secretary, Permanent Working Group Leader, Expert of Permanent Working Group);
 - *Integrated Rescue System* (Police Representative, Fire Rescue Service Representative, Medical Rescue Service Representative, eventually Army of the Czech Republic Representative);
- *Information Operation Centre;*
- *Intervention Leader.*

B. Identification of Processes

The next step in proposal of design patterns is identification of processes and procedures carried out for in order to bring a leakage of dangerous substance under control. Such accident must be reported to an Information Operation Centre (IOC). This process is called notification of emergency. In the case of a large-scale emergency, it is possible to declare a State of Emergency. Summoning of the Emergency Staff follows (process of summoning of the Emergency Staff). The persons responsible are summoned to determine the place and time within this process. Subsequently, it is possible to carry out the processes on the Emergency Staff level. In general, they are processed according to a regional accident plan or an

external accident plan of an organization with a possibility of a dangerous substances' leak [5]. In particular, these processes are as follows:

- 1) *Notification process* – the ways of informing parts of IRS about an accident that has just occurred, deals with notification schemes including contact information, list of the notification system, which is provided by an operator and patterns of primary information about an accident.
- 2) *The process of warning population* – the ways to alert the public; description of the expected ways how the public should react to the warning, the ways how to inform the public about their expected behavior during the accident and once it is over, the responsibility for the warning.
- 3) *Processes of sheltering, evacuation and individual protection of the population* – for practical reasons, these plans were merged into a plan of dealing with all the three mentioned areas; during an accident, the priority is to put up improvised shelters and protect the public.
- 4) *IRS action process* – provides a means of coordination of the intervening parts of the IRS, defines the location of probable deployment of components, including ways to determine access roads and it also lists technical and protective equipment.
- 5) *Decontamination process* – decontamination of persons specifies the ways, means and immediate surroundings of the affected by the accident, the resources needed for decontamination and methods for their protection.
- 6) *Monitoring process* – describes the methods of monitoring and communication of the variables measured (weather, concentration), it defines responsibilities and measures.
- 7) *Traumatology process* – provides information about dangerous effects on the human body and performs diagnosis of body contact with the hazardous substance; plans medical procedures, policies and procedures for implementation of medical assistance and ways of securing medical assistance of evacuated and sheltered population.
- 8) *Veterinary emergency process* – describes the status and location of livestock in the emergency planning zone. It sets out measures for ensuring their survival, methods of treatment and classification the health of the affected farm animals. It also encompasses action against intoxicated animals including the disposal of dead ones.
- 9) *Process for prevention of distribution and use of food, feed and water contaminated with dangerous substances* – provides means of control of contaminated food, feed for animals and water, giving instructions on how to prevent their distribution, dispose the matter and ensure safe distribution of food, water and feed.
- 10) *Process for preventive measures to prevent or restrict domino effect* – it contains a list of resources that may be vulnerable to domino effect in an accident, including measures that may prevent or limit the domino effect.
- 11) *Treatment of deceased persons in the affected area* – governs the search for deceased persons, identification methods, handling the deceased bodies and methods of

their burial.

- 12) *Action processes to prevent or limit the impact of the accident on the environment* – an overview of the impact of hazardous substances on the environment, review of measures to prevent or mitigate the impacts of the accident on the environment, including accountability for these measures.
- 13) *Arrangements for ensuring public order and security control and planning the movement of people and traffic* – defines a solid guard to prevent access to contaminated areas, mobile patrols intended for informing the public about the potential danger; creating of escort groups, filter points, information centre, defining driveways for intervening components, diversion of access roads to a secure area, power and resources, tasks, operations centre and a communication plan.

The solving of the Emergency Processes on the staff level is very complex therefore it is suitable to solve the problems of process identification iteratively. All the above stated processes are classified as Primary processes. There is naturally a whole range of supporting processes within Emergency Staff activities. Regarding to the application of iterative life cycle within methodology application, these processes will be identified in the next phases of the project.

C. Integration of User Roles and Processes

For the purpose of Integration of the User Roles and Processes of the Emergency Staff, a Use Case diagram was used. This diagram illustrates their mutual connection. The resulting diagram describes the most important user roles such as Information Operation Centre, Emergency Staff Leader, Intervention Leader and Emergency Staff Member. At the beginning, a user of Information Operation Centre receives information about an abnormal event in a process called Receiving Notification of Emergency. If they evaluate it as a large scale emergency, they gather the Emergency Staff. The Emergency Staff then calls in the Emergency Staff Leader (Mayer) by means of the process named Notify the Emergency Staff. The Use Case informs the participating Emergency Staff Members as well. The result is that Emergency Staff that solves the Emergency in cooperation with the Intervention Leader is gathered and ready. There is a whole range of processes within the Emergency Staff, called Emergency Processes of Emergency Staff. These are namely the 13 above-stated processes running on the Emergency Staff level, which have similar properties and are described in the Use Case diagram with the usage of heredity. The responsible person for all the processes is the Emergency Staff Leader. Emergency Staff Members are all at his disposal. Final hierarchical command is common across all the actions taking part in the Emergency response and making it more effective and efficient.

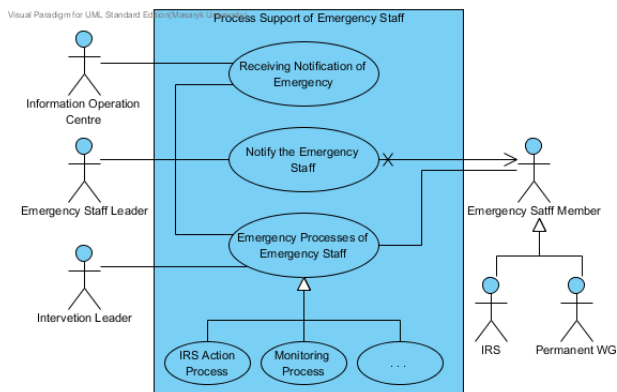


Fig. 2 Use Case diagram of Process Support of Emergency Staff

The first step is to get acquainted with the business requirements that have been composed and to understand the function of the processes on the Emergency Staff level. In the case of bigger project team participation, this is a key point. Subsequently, it is possible to start with modeling of identified processes and with their further analysis.

D.Design Processes

Design and Modeling of the processes is the next step. Outputs of Requirements are the identified processes and user roles participating on them. The aim of this part is to model the identified processes and to specify them in detail. The result is a view on partial actions and user roles that are responsible for the actions.

There is a simple process, describing a response to an emergency on the Emergency Staff level, on the highest Process Analysis level. It is the highest level of abstraction. Please note that the process actions correspond with the individual Use Case (Fig. 2). However, the process describes a time sequence of these actions, which is not visible on the use case diagram. The process starts with receiving a notification about an emergency. If an Emergency State is declared, it is necessary to gather the Emergency Staff. Subsequently, the whole range of Emergency Processes is carried out on the Emergency Staff level in order to deal with the emergency. Once these actions are carried out and the emergency is over, it is possible to disband the Emergency Staff. The process on the highest level is presented in the following Fig. 3.

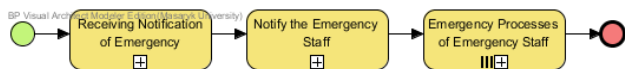


Fig. 3 Process of Solving of Emergency Situation

The next step is to model the activities displayed in the Fig. 3 in detail. The first of them is called Receiving Notification of Emergency (Fig. 4). On a lower level, it is possible to consider this action as a sub-process. The process starts when the operation centre receives a notification of a leakage of hazardous substances by phone. The operator obtains details of concerning the location, the accident scope and the number of people injured. The operator must verify, whether the call is

not only a false alarm. Subsequently, there is an evaluation of relevance of the emergency. The units of IRS are dispatched to the place of the leak and if the situation is serious, an emergency state is declared. As the aim of the project is to create information support for the Emergency Staff, the process continues just in the case of the Emergency and when the emergency state is declared. After the declaration of the emergency state, the mayor of the competent municipality is informed. A standard formulated report describing the status of the emergency is created to provide the mayor with all the relevant information. Upon its receipt, the mayor of the competent township is obliged to verify the information and gets in contact with the Information Operation Centre. If the information is verified successfully, the Emergency Staff is gathered. In the other case, the process is cancelled.

The next step is a process of Summoning of the Emergency Staff. It is a very simple process, in which the mayor gathers the Emergency Staff members and commences its activity. In the first case, the mayor specifies a notification message, in which he or she informs the individual Emergency Staff Members about the emergency and the place and time of the first Emergency Staff meeting. Based on the character of the emergency, the mayor can adjust the Emergency Staff structure and invite other specialists into the Emergency Staff. All the Emergency Staff Members are then sent a notification with information about the situation. They can confirm or reject their presence. The mayor is notified about the confirmation of each member and if needed, he can send a fast reaction. Afterwards, it is possible to begin the activity of the Emergency Staff in a time which has been specified in advance and to start to deal with the emergency itself. All the actions are adequately documented and therefore a report on the Emergency Staff activity commencement can be created. The whole process of gathering of the Emergency Staff is in Fig. 5.

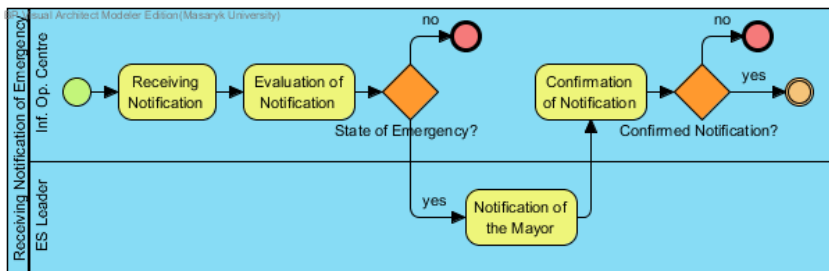


Fig. 4 Receiving Notification of Emergency

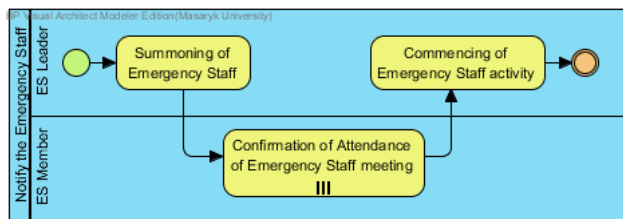


Fig. 5 Notify the Emergency Staff

Various activities and tasks are performed on the Emergency Staff level. The mayor of the competent municipality (Emergency Staff Leader) is responsible for the response to the emergency and he or she gradually assigns the tasks that should lead bringing the Emergency under control. The individual activities that must be carried out are defined by law [6]. The Mayor has a possibility to choose a task and a user role or person that is responsible for the task and he or she can also specify the task in more detail. The party chosen performs the task and adequately documents the solution. Once the task is completed, the mayor checks whether this is really the case. If the task is not completed or completed just partially, the Mayor has an opportunity to re-assign or modify the task. When all the specified tasks have been completed, it is possible to end the emergency and to disband the Emergency Staff. The corresponding process map is depicted in Fig. 6.

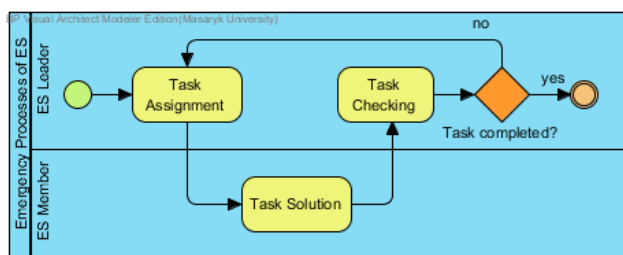


Fig. 6 Emergency Processes of Emergency Staff

Similarly, it is possible to continue in the decomposition and modeling of the processes into further detail. However, to show the Design Patterns, the level that has been presented so far is sufficient. If a complex information system for the Emergency Management were to be created, the processes would have to be more complex and modeled into a further level of detail.

V. CONCLUSION

The main aim of this paper is to define and describe Design Patterns for emergency management processes. Therefore it is necessary to identify user roles and model high level processes involved in emergency management. Selected procedures are described from the view of general process management methodology and business process management notation was used for the representation of Design Patterns. The paper emphasizes the use of standards and best practices in the field of process management. The result represents a comprehensive Design Patterns for the area of emergency management processes, particularly oriented at large-scale accident caused by selected hazardous chemical substances and chemical products.

For an overall understanding of the described issue it is also appropriate to familiarize with the Process Framework for Emergency Management [13]. This contribution emphasizes the importance of the two perspectives in the deployment process of emergency management. It should be noted that the design patterns itself are not sufficient for the automation of emergency management processes. It should be supplemented by a methodology and architecture that defines how to proceed with process automation and deployment. Such methodology and architecture have been already published in the articles entitled Process Methodology for Emergency Management [14] and Process-oriented Architecture for Emergency Scenarios in the Czech Republic [12].

Members of Emergency Staff understand emergency planning issues and emergency management more easily when illustrated on real examples. The resulting Design Patterns allows to model emergency scenarios using process diagrams in the business process management notation. The maps can be configured and deployed on a process engine lately for the purpose of simulation emergency processes and creating training environment. Finally, it should be noted that the proposed Design Patterns is suitable not only for educational purposes, but also for the automation and deployment of real emergency scenarios in the Czech Republic.

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REFERENCES

- [1] Arlow, J., Neustadt, I. UML 2 And The Unified Process, Practical Object-Oriented Analysis And Design. Second Edition. Addison-Wesley, 2005. ISBN 0321321278.
- [2] Committee for Civil Emergency Planning. Náležejícímu s podezřením na přítomnost B-agens nebo toxinů (Finding the Subject with a Suspected on Presence of B-agents or Toxins). STČ 05/IZS. Katalogy typových činností integrovaného záchranného systému. 2006.
- [3] Czech Republic. Law No. 239/2000 Coll., on the Integrated Rescue System and on amendment of certain codes, in latter wording. In Czech Republic Status Book, 2000. ISSN 1211-1244.
- [4] Czech Republic. Law No. 240/2000 Coll., on crisis management and on modification of certain codes (Crisis Code), in latter wording. In Czech Republic Status Book, 2000. ISSN 1211-1244.
- [5] Czech Republic. Legislation Decree. 328/2001 Coll., on some details of the security of the integrated rescue system, in latter wording. In Czech Republic Statute Book, 2001. ISSN 1211-1244.
- [6] Czech Republic. Law No. 59/2006 Coll., concerning prevention of major accidents caused by selected dangerous chemical substances or chemical preparations. In Czech Republic Statute Book, 2006. ISSN 1211-1244.
- [7] DeMarco T. Structured Analysis and System Specification. Prentice Hall PTR. Facsimile edition. 1979.
- [8] Diehl, S., Neuvel, J., Zlatanova, S. et al. Investigation of user requirements in the emergency response sector: the Dutch case. In Proceedings of the Second Gi4DM. Goa, India, 2006.
- [9] Eriksson, H.E., Penker, M. Business Modeling with UML: Business Patterns at Work. John Wiley & Sons, 2000. 459 p. ISBN 0-471-2955-5.
- [10] Haddow, G., Bullock, J. Introduction to Emergency Management. Third Edition, Oxford: Elsevier, 2008. ISBN 978-0-7506-8514-6.
- [11] Kubiček, P., Ludík, T., Muličková, E. et al. Process Support and Adaptive Geovisualisation in Emergency Management. In Geographic Information and Cartography for Risk and Crisis Management - Towards Better Solutions. First Edition. Heidelberg: Springer, 2010. ISBN 978-3-642-03441-1.
- [12] Ludík, T., Navrátil, J., Langerová, A. Process-oriented Architecture for Emergency Scenarios in the Czech Republic. In International Conference on Business Process Management. Venice: World Academy of Science, Engineering and Technology, 2011. ISSN 2010-3778.
- [13] Ludík, T., Ráček, J. Process Framework for Emergency Management - Solving of Emergency Situations by Way of Business Processes. In Proceedings of the 6th International Conference on Software and Database Technologies. Portugal: SciTePress, 2011.
- [14] Ludík, T., Ráček, J. Process Methodology for Emergency Management. In IFIP Advances in Information and Communication Technology, Heidelberg: Springer, 2011.
- [15] Ministry of the Interior. Velitelzásaupříženípožárního zásahu a záchranných prací jednotek (Intervention Leader in Managing the Fire Response and Rescue Units). Metodický list 2Ř. In Bojový řád jednotek požární ochrany - taktické postupy zásahu. Prague: Ministry of the Interior of the Czech Republic, the General Directorate of Fire Rescue Service of CR, 2007.
- [16] Ministry of the Interior. Large-scale accident caused by selected dangerous chemical substances. Model Action Plan. Prague: Ministry of the Interior of the Czech Republic, 2010.
- [17] Ministry of the Interior. Metodika zpracování krizových plánů podle § 15 až 16 nařízení vlády č. 462/2000 Sb., k provedení § 27 odst. 8 a § 28 odst. 5 zákona č. 240/2000 Sb., o krizovém řízení a o změně některých zákonů (krizový zákon), ve znění pozdějších předpisů (Methodology for Emergency Plans Elaboration According to Valid Legislation). MV-76085-1/PO-OKR-2011. Prague: Ministry of the Interior of the Czech Republic, 2011.
- [18] Noran, O. Business Modeling: UML vs. IDEF [online]. Brisbane, Australia: Griffith University, 2000. [2013-10-10]. Available: <http://www.cit.griffith.edu.au/~noran/Docs/UMLvsIDEF.pdf>
- [19] NRC. Successful response starts with a map: improving geospatial support for disaster management. Committee on Planning for Catastrophe and National Research Council. Washington: U.S. National Academies Press, 2007.
- [20] Object Management Group. Business Process Modeling Notation (BPMN) [online]. Version 2.0 Beta. Document Number: dtc/2009-08-14. Object Management Group, 2009. [2013-10-10]. Available: <http://www.omg.org/spec/BPMN/2.0>
- [21] Petri, C. Kommunikation mit Automaten. Dissertation Thesis. Bonn: University of Bonn, 1962.
- [22] Řepa, V. Podnikové procesy, procesní řízení a modelování. (Business Processes, Process Management and Modeling) Prague: Grada, 2007. ISBN 9788024722528.
- [23] Vondrak, I. 2010. Methods for Business Modeling [online]. Ostrava: Technical University of Ostrava. [2013-10-10]. Available: <http://vondrak.cs.vsb.cz/download.html>
- [24] Weske, M. Business Process Management, Concepts, Languages, Architectures. Berlin, Heidelberg, New York: Springer, 2007. ISBN 9783540735212.
- [25] White, S. Introduction to BPMN [online]. IBM Corporation, 2004. [2013-10-10]. Available: [http://www.bpmn.org/Documents/Introduction to BPMN.pdf](http://www.bpmn.org/Documents/Introduction%20to%20BPMN.pdf)
- [26] Wisner, B., Blaikie, P., Cannon, T., Davis, I. At Risk - Natural hazards, people's vulnerability and disasters. London: Routledge, 1994. ISBN 0415252164.
- [27] Workflow Management Coalition. 1999. Terminology & Glossary [online]. Document Number WfMC-TC-1011. Workflow Management Coalition. [2013-10-10]. Available: http://www.wfmc.org/standards/docs/TC-1011_term_glossary_v3.pdf
- [28] Workflow Management Coalition. Workflow Management Coalition [online]. Cohasset, USA. 2012. [2013-10-10]. Available: <http://www.wfmc.org/>
- [29] Yourdon, E. Modern structured analysis. Englewood Cliffs: Prentice-Hall, 1989.