Information Support for Emergency Staff Processes and Effective Decisions

Tomáš Ludík, and Josef Navrátil

Abstract—Managing the emergency situations at the Emergency Staff requires a high co-operation between its members and their fast decision making. For these purpose it is necessary to prepare Emergency Staff members adequately. The aim of this paper is to describe the development of information support that focuses to emergency staff processes and effective decisions. The information support is based on the principles of process management, and Process Framework for Emergency Management was used during the development. The output is the information system that allows users to simulate an emergency situation, including effective decision making. The system also evaluates the progress of the emergency processes solving by quantitative and qualitative indicators. By using the simulator, a higher quality education of specialists can be achieved. Therefore, negative impacts resulting from arising emergency situations can be directly reduced.

Keywords—Information Support for Emergency Staff, Effective Decisions, Process Framework, Simulation of Emergency Processes, System Development.

I. INTRODUCTION

THE objective of this paper is to describe the creation of a process simulator in order to prepare and train emergency staff members at national and international level. Preparation is aimed at promotion of processes and effective decision-making during the security environment analysis and crisis management. It equally includes comprehensive training and evaluation of the human factor. This goal is based on detailed analysis of the current state [9], [10], [15] and also reflects the requirements of experts in the field of emergency management [1], [5].

Paper is divided into three parts. The introduction describes approaches and methods of process management, which have been selected to create the simulator. Later, the development of process simulator is described in terms of the different phases of chosen methodology and currently the software architecture is presented. The final part of the paper presents the obtained result and output of the research and possibilities of created system at process simulation.

A number of emergency situations are solved at the level of Emergency Staff. The aim is to develop a comprehensive information system that will cover these situations. For this reason, an iterative approach, that allows implementation of the system by parts, was selected. Design of the system is illustrated on chosen situation, which is the leak of chemical hazardous substances.

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A. Problem Domain Definition

Large-scale accident caused by selected hazardous chemical substances and chemical products is extraordinary event manifested by uncontrolled flows of energy (fire, explosion), and leaks of toxic substances [6]. These are partially or totally uncontrollable, time-and space-bounded event which was created or whose inception is imminent in connection with the use of the building or facility where the hazardous substance is manufactured, processed, used, transported or stored, and that leads to immediate or delayed serious damage or threat to life and health of people, livestock, environment or for damage to property [14].

To solve large-scale emergency, it is appropriate to use the corresponding Modell action plan called Large-scale accidents caused by selected hazardous chemical substances and chemical products processed by Ministry of Interior of the Czech Republic [14], which addresses issues across the board-wide Czech Republic. Another information source is Operational plans at regional level. These specifically include individual emergency plans, which are subdivided into: Regional Emergency Response Plan are processed by Fire fighters in cooperation with the region, all the possible places where accidents can occur mainly anthropogenic action [3], [4]; Internal Emergency Plan are focused on particular facilities or subject, they are processed by the body meeting the requirement of the legislation [2]; External Emergency Plan are focused on particular facilities or subject too, but they are processed by Fire fighters processes [3].

Desired state is the stabilization of activities in the chemical facility and decontamination of equipment in the immediate vicinity of the accident. The ultimate aim is the stabilization of public service authorities.

II. APPROACHES AND METHODS

Process Management is a field of combining management and technology focused on aligning organizations with the wants and needs of clients [17]. 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.

A. Process Management Approaches

Nowadays, there are two significant streams in the field of Process Management: i.e. Business Process Management presented by *Object Management Group (OMG)* and Workflow Management, which was originally created by

Workflow Management Coalition (WfMC).

Business Process Management is based on the observation that each product that a company gets to the market is the result of a number of performed activities [17]. Business processes are the key instruments to organize these activities and to improve the understanding of their interrelationships. Information technology deserves an important role in business process management, because more and more activities that a company performs are supported by it [17]. BPM activities can in general be grouped into five phases: Defining, Modelling, Configuration, Execution/Monitoring, and Optimization. They are related to each other and organized in a cyclical structure, showing their logical dependencies (BPM Life-Cycle).

Workflow Management is built on architectural representation of a workflow management system called Workflow Reference Model that is developed by WfMC. It identifies the most important system interfaces, covering broadly five areas of functionality between a workflow management system and its environment [7].

B. Process Framework for Emergency Management

Process Framework for Emergency Management is a new progressive view on process support of organizations in the private and public sector [12]. It is created for the purpose of better understanding of issues that are connected with process deployment in the specific area of interest (e.g. emergency management, education). The general purpose of the model is given by two main views, which are Methodology view and the global Architecture view, see Fig. 1 [12].

The first view is created by Process Oriented Methodology [13]. This view is based on the Business Process Management life-cycle. The designed methodology consists of five basic phases, where every phase is further decomposed. Namely there are these phases: Defining, Modelling, Configuration, Execution/Monitoring, and Optimization. The methodology contains user roles, which are necessary for correct progress and the roles show responsibilities for the particular tasks. The roles are not just the ones focused on the ICT view of process deployment, but there are also roles for emergency management. The next essential parts of created methodology are individual work products, either input or output.

The second part of the process framework is Software Architecture [11]. It is based on WfMC principles and primarily focused on software tools required for process deployment into organisations. The major task is to define suitable interfaces for communication among individual components of architecture [7]. The architecture view is situated on the right side of the process framework. The aim of the view is to create a global architecture that will serve as the essentials for modelled process instances deployment so that these instances could cooperate with other services and tools within clearly defined interfaces.

III. SYSTEM DEVELOPMENT

Process Framework for Emergency Management has been chosen for the development of simulator, which enables training of the Emergency Staff members. Framework represents comprehensive perspective suitable for complex automation of processes in the emergency management field. Process Framework consists of two main parts: Process Methodology and Software Architecture. Therefore, the next part of this paper describes the chosen methodology and software architecture for process simulator development.
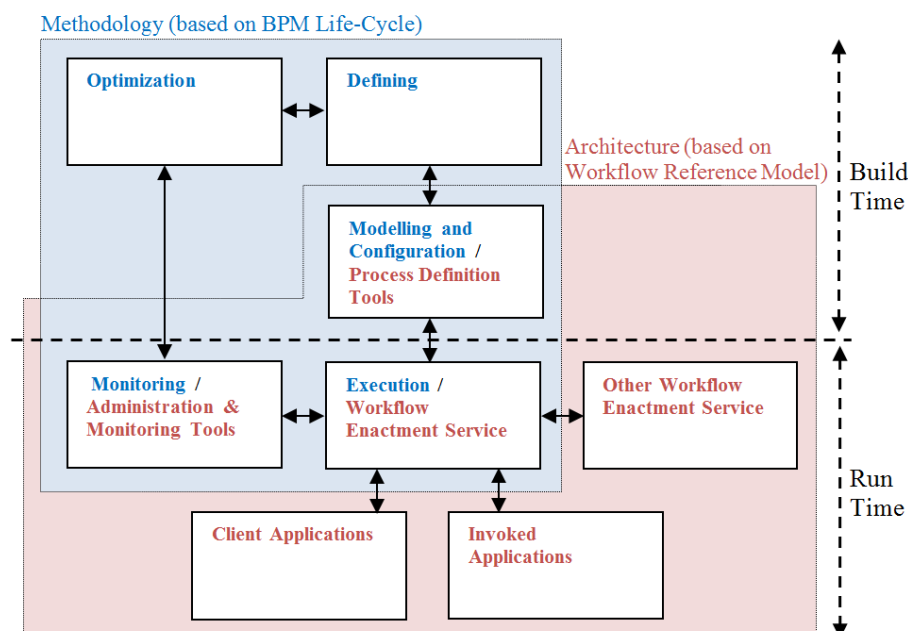

Fig. 1 Process Framework for Emergency Management

A. Process Methodology

Following first three phases of chosen process methodology was used: Identification, Modelling, and consequently the Configuration. The result of application of these phases is the comprehensive software that is capable to simulate processes at the level of Emergency Staff and the progress is described in subsequent section.

The first step is identification of basic processes and user roles at the level of Emergency Staff. This identification is based on the analysis of relevant legislation and the model types of activities. Four user roles has been identified: Operational Centre, Head of Emergency Staff, Emergency Staff Member and Intervention Commander. Subsequently, processes based on the legislation of the Czech Republic were identified [4]. The legislation describes the activities of Emergency Staff. Used case diagram (see Fig. 2), which is one of the UML (Unified Modelling Language) diagrams, was chosen to determine responsibilities and participation of user roles at identified process.

Created software simulator works in way, that at the beginning user Operational Centre receives information about extraordinary event in the process called Receiving Information about Emergency and in case that information are evaluated as large scale emergency situation. The Emergency Staff is alerted. The members of Emergency Staff are notified by the Head of Emergency Staff in the process called Notification of Emergency Staff. The result of this process is meeting of Emergency Staff that solved arisen emergency situation with participation of Intervention Commander. At the level of Emergency Staff there are solved many processes. These processes which are described in detail in legislation [2]are collectively called as Emergency Processes of Emergency Staff. Particular processes are described in the Use Case diagram by inheritance. Head of the Emergency Staff is responsible for all processes and delegates them to Members of Emergency Staff. The resulting hierarchical chain is

commonly for emergency situation and allows to solve emergency situation more efficiently.

The next phase of the methodology is modelling phase. It represents a detailed analysis initially identified processes. The processes have been described in terms of individual activities and tasks and also their sequence is clearly defined. Business Process Modelling Notation (BPMN) was used for the graphical representation of the processes. The notation is standard for process modelling [16]. At the same time, analysing of the data layer and its balancing with the modelled processes was emphasized. This solution will allow to Emergency Staff to have all the information available to solve the emergency task.

To illustrate the analysis process Receiving Information about Emergency is described in detail. The process begins when an operational centre receives the caller's information on the release of dangerous substances. Operator obtains information about location of leakage and the number of injured persons. The operator also verifies possibility of the false alarm. Subsequently, assessment of the seriousness of an incident is carried out. The emergency services of IRS are called to the area of leakage, and in case of serious emergency situation the state of crisis is declared. Since the project aim is to develop information support for the emergency staff, the process continues only if there is the crisis situation and therefore the crisis state is declared. After declaring the state of crisis, the mayor of the particular municipality is informed about the situation. Standardly formulated report is used to inform the major. The report contains information about arisen crisis. After receiving the report, the major of municipality have to verify the information and contact operations center again. Afterwards Emergency Staff may be called. Otherwise, the process is completed. Graphical representation of the process in BPMN notation is shown in Fig. 3. The analysis of other processes of the Task Force is implemented similarly.
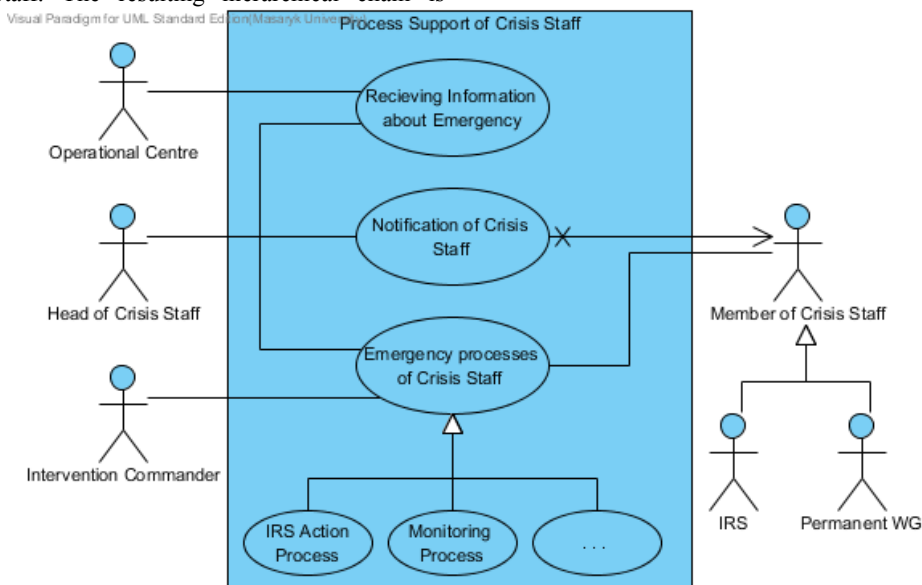

Fig. 2 Use Case Diagram of Information Support for Emergency Staff

The last step of the simulator is configuration of modelled processes. Based on the analysis of available services it can be decided, which existing services can be used and on the contrary which must be set up as new. In terms of the release of hazardous substances, it is possible to use a wide range of existing services, e.g.: A system for modelling leakage of hazardous substances warning system integrated services, Geographic Information System or Traffic information system. Subsequently, own services were formed. These services are primarily User Tasks and they are represented in the user interface forms. Each designed service was also tested.

Created User Tasks are dependent on the chosen architecture jBPM (see next section). A user task node represents an atomic task that needs to be executed by a human actor [8]. Although jBPM has a special user task node for including human tasks inside a process, human tasks are considered the same as any other kind of external service that needs to be invoked and are therefore simply implemented as a domain-specific service. To have human actors participate in your processes, it is needed to [8]:

- Include human task nodes inside the process to model the interaction with human actors;
- Integrate a task management component;
- Have end users interacted with a human task client to request their task list and claim and complete the tasks assigned to them.

It is also necessary to define Key Performance Indicators (KPI) in the Configuration phase. The jBPM Business Activity Monitoring (BAM) is used to handle the KPIs. Operations with the KPIs, from its definition to their graphical representation, are described in consequent part. Firstly, the principles of data storage are described. The data should be used for KPI by using the History log. Then there are the principles of BAM for jBPM, which is used to manipulate and display KPIs in graphical form.

B. Software Architecture

It is a necessary to choice software architecture for the intention of subsequent automation of emergency processes. Business Process Management Suite and specific tool jBPM is selected in order to simplify modification and subsequent scalability. The instrument was chosen in respect of its easy applicability and open platform that can be readjusted under the needs of the project. The basic components include: Eclipse Process Designer, The jBPM Runtime Engine and Management Console.

Eclipse Process Designer represents Eclipse plugin that simplifies developing applications with jBPM, make it easy to get started. The Drools Eclipse plugin is currently used to support the creation, editing, testing and debugging of the business processes [8]. The graphical editor allows to drag-and-drop nodes and connections and use the properties view to fill in additional details.

The jBPM Runtime Engine runs in any Java environment. From a spring based web application for a grocery store on Tomcat over a top scale banking application to a plain standalone Java application [8]. The jBPM engine can be used as a remote service or as a component inside the application. Inside the application, it binds to transactions so that it can easily combine particular domain model updates with process execution in a single transaction.

Business processes can be managed through a web Management Console. This includes features like managing the process instances (starting/stopping/inspecting), inspecting the (human) task list and executing those tasks, and generating reports [8]. It can be used to: Manage process instances, Manage tasks and Reporting. Manage process instances allow start new process instances or inspect the state of currently running instances (annotated on the process diagram). Manage tasks represents cases in which these tasks are assigned to human actors, can be looked up and completed by using task lists or task forms [8]. Reports can be generated on basis of the history information collected when executing processes.

IV. RESULTS

The result of the process framework application for crisis management is functional software that is capable to simulate process at level of emergency staff. Final solution can be simply deployed at the server, whereas the client stations have access to the simulator by using a web browser. The complete solution is independent on the platform and can be used universally. The system logs the users under specific roles of emergency staff and subsequently, users in cooperation with the simulator solves the emergency situation. The software accompanies users step-by-step for purpose of quick and effective solutions. The system allows you to divide tasks among different users or groups, who afterwards deal with tasks in parallel with higher efficiency.
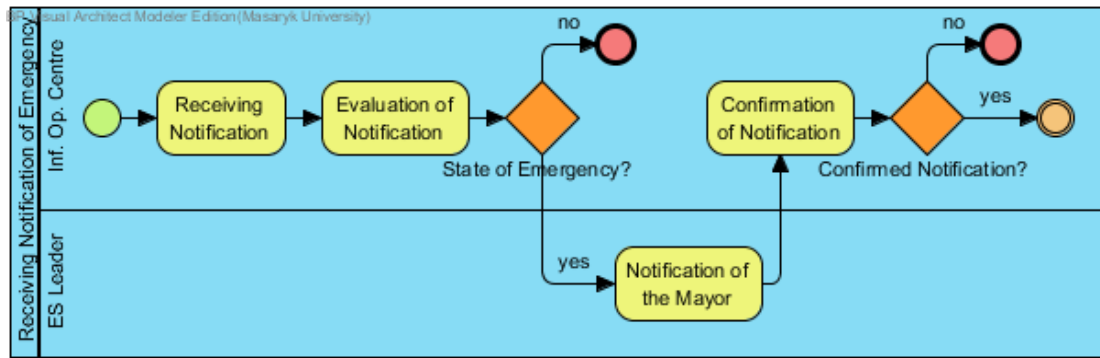
Fig. 3 Receiving Notification of Emergency

The total process solution to the crisis can track and monitor in detail. For this purpose, it used key performance indicators (KPI). The process can be evaluated both quantitatively and qualitatively. Quantitative solution is to track the time course of such process. The user knows exactly how long the task solved and also has the possibility to statistically compare with others who have solved the crisis. This makes it possible to monitor a wide range of other quantitative factors. Qualitative contrast solution lies in the fact that the course of the process is recorded and then reviewed by an expert. Based on expert estimation is the process of solving crisis situations evaluated. The user knows in which situations are decided incorrectly or inefficiently.

The system is also integrated with other systems for crisis management. Example, a user will enter the need to model the release of hazardous substances from the external tools (Terex, Aloha). The results are then uploaded directly into the built simulator and used as a further solution to the crisis between multiple users. Integration with geographic information system or alarm service operated by the Czech Hydrometeorological Institute is achieved through standardized interfaces.

The origin of Workflow Management in the present form goes back to the year 1993 when the Workflow Management Coalition (WfMC) was established. WfMC is a global organization of adopters, developers, consultants, analysts, as well as university and research groups engaged in workflow and workflow management. The WfMC creates and contributes to process related standards, educates the market

on related issues, and is one of few standards organization that concentrates purely on process.

V. CONCLUSION

The main aim of this paper is to describe and implement process simulator for education of the Emergency Staff. Therefore it is necessary to identify, model, and then configure the processes involved in disaster management. Selected procedures are described from the methodological perspective but also from the perspective of software architecture, which allows processes automation. The paper emphasizes the use of standards and best practices in the field of process management. The result represents a comprehensive information support for education of the Emergency Staff.

For an overall understanding of the described issue it is also appropriate to familiarize with the Process Framework for Emergency Management [12]. This contribution emphasizes the importance of the two perspectives in the deployment process of emergency management. It should be noted that the architecture itself is not sufficient for the automation of emergency management processes. It should be supplemented by a methodology that defines how to proceed with process automation and deployment. Such methodology has been already published in the article entitled Process Methodology for Emergency Management [13]. This methodology has been used during the automation of selected emergency management scenarios described in this paper.

Fig. 4 User Interface of System for Information Support of Emergency Staff Processes

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