Process Methodology for Emergency Management

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Abstract. Emergency management is represented by managerial functions which aim to reduce vulnerability to hazards and to cope with disasters. Emergencies often have direct impact on the environment. This paper focuses on identification and subsequent software support processes in the emergency management. The paper aims to describe a process methodology for emergency management in details. The methodology describes how to manage an information system development suitable for emergency management, which is built on business processes. The methodology consists of five main phases. Each phase is described in terms of individual activities, work products, and user roles. The next part of the paper recommends the use of particular technologies, tools and resources that have been successfully proved in the analysis of emergency situations in the Czech Republic. The straightforward outcome of the novel process methodology is more effective solution of emergency situations and therefore the reduction of negative environmental impacts.

Keywords: Process Management, Emergency Management, Process Methodology, Recommendations.

1 Introduction

The emergency management requires considerable effort. To manage emergencies, it is necessary to spend human resources and also technical resources. It is useful if there are available some best practices in solving the emergencies, and also specified responsibilities for particular activities. To capture such information it is appropriate to use the process management, which has been approved in the private and public sector [3].

Identification and subsequent automation of the process is a challenging issue. At present, there are primarily two different approaches to the business process deployment. The first approach is based on the business process life-cycle, the second one on the overall architecture which supports the business process deployment. Both of these approaches are supported by the multinational corporation (Object Management Group and Workflow Management Coalition), which enforces standards in this field.

It is convenient to integrate the above mentioned approaches to the process management for effective process deployment and create a common framework for

an unified view of the process deployment. Such a view is defined by Process Framework for Emergent Management that takes into account specific factors relating to the emergency management [4].

The Process Framework for Emergency Management provides a basic view of the process deployment from the methodology and architecture point of view. For this reason, this paper aims to describe the process-oriented methodology in detail, which is an essential part of the framework.

2 Methodologies Based on Business Process

There are many methodologies that lead the user through the process deployment, e.g. *Object Process Methodology*, *Rational Unified Process*, *Methodology for Modelling and Analysis of Business Process* or *Business Driven Development*. The business process analysis is the principle of these methodologies, but the process automation of does not follow the process management ideology. The next part of the paper briefly describes the methodologies and also shows their disadvantages.

2.1 Object Process Methodology

Object Process Methodology (OPM) [1] is an approach to designing information systems by depicting them using *object models* and *process models*. OPM combines a minimal set of building blocks with a dual graphic-textual representation in a single diagram type. This makes OPM formal yet accessible to systems engineers and other stakeholders, enabling them to be involved through modelling from the early stages of requirements formulation.

The main disadvantage of this approach is the non-standard diagram notation, which has similar properties to the Data Flow Diagram (DFD). Another disadvantage is a low correlation between modeled process diagrams and their subsequent implementation.

2.2 Rational Unified Process

The Rational Unified Process (RUP) [7] is an iterative software development process framework created by the Rational Software Corporation, a division of IBM since 2003. RUP is not a single concrete prescriptive process, but rather an adaptable process framework, intended to be tailored by the development organizations and software project teams that will select the elements of the process that are appropriate for their needs.

The main disadvantage of RUP methodology is that business process analysis is used only at the beginning in order to create business requirements. The final application reflects the business processes, but there is not created a closer bond with them. Therefore, even a small change of business process leads to a fundamental change of the created information system.

2.3 Methodology for Modelling and Analysis of Business Process

Methodology for Modelling and Analysis of Business Process (MMABP) [6] is based on the fact that a business process model is next to an object model one of the two key assumptions of the information system global model. Both of these models form the basis of a business world general model. The object model is a static model of reality. In contrast, a process model is dynamic, and therefore describes the transition from initial to final states of the process.

The advantage of this approach is the use of BPMN for process diagrams and Class diagram (UML) for describing objects. The disadvantage of this methodology is its focus on process analysis and modelling. The methodology therefore does not cover the entire business process life-cycle.

2.4 Business Driven Development

Services-Oriented Architecture (SOA) provides an IT framework along with a set of principles and guidelines to create IT solutions as a set of reusable, composable, and configurable services that are independent of applications and runtime platforms. Transitioning an enterprise to SOA requires a Business Driven Development (BDD) approach that uses business goals and requirements to drive downstream design, development, and testing [5]. It brings a much needed flexibility in enterprise IT and helps to align IT solutions with business needs.

It is one of the best so far described methodologies from the view of the close interdependence to the business processes. But there is missing the application of a workflow reference model that allows to deploy the modelled process instance directly to the workflow engine.

3 Process Oriented Methodology

The created process-oriented methodology is based on the above mentioned methodologies but also eliminates their disadvantages. This innovative methodology is described in terms of different phases, from which it is composed, as well as in terms of responsible user roles and work products generated by this methodology.

3.1 Phases

The first phase of the methodology is *Identifying*. It tries to define the main strategic objectives of the organization. In accordance with the objectives the processes that bring added value to the organization are identified, directly or indirectly. Accordingly, these processes can be divided into *primary*, *support* and *management* processes [2]. It is also appropriate to assign responsibility for individual processes and particular activities as well. It is appropriate to use the Use Case Diagram to integrate the processes and user roles. The output of the phase is a list of business requirements (more details are in the section 3.3). It is convenient to define the

Glossary to better understand the area of interest, which facilitates communication between user roles. The last tasks of the phase are verification and validation of business requirements.

In the *Modelling phase*, the business process is in detail modelled and decomposed into several levels, depending on its complexity. During this phase the emphasis is on the correct data flow in processes. Decision-making in processes are solved by using business rules, which could be changed during the process runtime. Designed process should be simulated in this phase. Simulation can reveal bottlenecks in the process and also visualize the process functions. The outcome of this phase is the system requirements determination that are in accordance with business requirements. System requirements should be approved by the user-validation. One of the key elements in this phase is the appropriate automation level determination.

Configuration is the third phase and deals with a detailed set up of business processes. Processes are transformed from the modelling phase into the configuration phase mostly in BPEL. In this form they are accompanied by the necessary functionality build on service-oriented architecture. Processes consist of already existing services or of the brand new ones that need to be programmed. In this phase are created the key performance indicators that are intended for the process performance control during the runtime. In such way the comprehensive application is built on business process. Its instances can be deployed on the workflow engine. The created system is set to the end customer. The service and process testing, as well as system validation with respect to the system requirements belong to the control mechanisms of this phase.

Execution/Monitoring phase provides primarily two activities. First it is an administration of running process instances in the workflow engine. That allows the end users to effectively work with the processes. Created applications can be set up and configured during the runtime. Business rules enable the configuration of the branching in processes, which enables better response to possible changes in a company. Setting user rights and roles is another option. Roles and rights can be assigned or removed for the current or new users, according to their current responsibilities. This phase is also responsible for process monitoring and for gathering data about process run. Based on this information, it is possible to evaluate the process progress and partly adapt the process on the flow. Defined KPIs have a great impact. They enable overall control of the process and therefore also a rapid response to sudden changes.

The last phase is *Optimization*. This phase is crucial for continuous process improvement. During the monitoring phase the data about process instances are collected, which may result in some gaps in the modelled process. There are some advanced techniques of mathematical statistics or process mining available for the process instances analysis. Based on the results it is possible to choose two different approaches to process improvement. It is a Business Process Reengineering (BPR) or a Total Quality Management (TQM) [6]. TQM is focused on the consequent improvement of processes. On the other hand, BPR focuses on radical changes. According to the chosen approach, new specification of business processes is created.

3.2 Roles

Stakeholder represents interest groups whose needs must be satisfied by the project. It is a role that may be played by anyone who is (or potentially will be) materially affected by the outcome of the project.

Business analyst is a high-level role responsible for the business analysis and BPM work activities. The business analyst performs process modelling and creates functional specifications for process. This high-level role implies that the analyst might also take on more specialized tasks during the project.

Architect is a high-level role responsible for the overall work effort of creating the architecture and design of the system. More specialized roles, such as enterprise architect, application architect, SOA architect, and infrastructure architect, are actually responsible for various architectural work efforts that constitute the design phase of the project.

Developer is a high-level role responsible for the implementation of the solution (services).

Tester is a role responsible for performing activities required to test the application before it is deployed into a production environment.

Line Manager is a person who heads revenue generating departments (manufacturing and selling) and is responsible for achieving an the organization's main objectives by executing functions such as policy making, target setting, decision making.

3.3 Work Products

This section describes the outputs generated by the methodology. Thus outputs are quite a bit through the methodology phases and therefore only main outcomes of the various phases are described.

Business Requirements are requirements based on customer's wishes and their needs. They describe the principles and functioning of a company as a whole, defining its objectives [7]. Identified processes are part of these requirements.

System Requirements are the modeling phase results. These are the requirements for creating an information system built on business processes. Detailed and hierarchically organized process diagrams are part of this output. These requirements also describe the level of process automation.

Information System is a result of the configuration phase. Modeled processes are configured and composed of individual services. Thus created processes are deployed on a process engine, which interprets them. The workflow engine also allows interaction with users and external tools.

Monitoring data is an output of the monitoring phase. It contains information about process instances run, such as duration or cost of individual processes. It also records the passage through the business process, which can be useful in further analysis.

Strategic plans are the optimization phase outputs. The overall technology improvement (TQM, BPR) and strategic plans for further business process improvement are chosen in strategic plans.

4 Recommendations for Emergency Management

In case the methodology is used in the field of emergency management it is appropriate to consider certain features that arise from this specific area. This includes clearly defined organizational structure, legislative and other issues. Some features are illustrated on emergency management in the Czech Republic.

4.1 Organizational Structure

The Integrated Rescue System (IRS) is determined for co-ordination of rescue and clean-up operations in case, where a situation requires operation of forces and means of several bodies, e.g. fire fighters, police, medical rescue service and other bodies, or in case, where the rescue and clean-up operation is necessary to be co-ordinated from the Ministry of Interior or by a leader of region's level, or by mayors of municipalities with extended responsibilities [4]. As the Integrated Rescue System are therefore considered the co-ordinated proceedings of its bodies during preparations for emergencies, and during rescue and clean-up operations.

As permanent authorities for coordination of Integrated Rescue System bodies are considered the operational and information centres of the Integrated Rescue System, i.e. the operational centres of regional Fire Rescue Services and the Operational and Information Centre of the General Directorate of the Czech Fire Rescue Service.

4.2 Legislation and Documentation

There are many laws dealing with emergency management in the Czech Republic. Crisis management elements are codified in the Law No. 240/2000 on crisis management and on modification of certain codes (Crisis Code), in latter wording. Based on this law, state of danger can be proclaimed to overcome unfavourable trends of development. The other important Law is the Law No. 239/2000 on the Integrated Rescue System and on amendment of certain codes, in latter wording, is the basic legal frame describing situation around IRS.

Another feature of the emergency management is the detailed documentation that defines how to proceed in particular situations. The Contingency Plans belong to the basic documents. They contain a set of measures and procedures addressed to crisis situations, i.e. they contain sum of planning, methodological and informational documents used in decision-making, management and coordination of tasks in the emergencies.

4.3 Different Types of Information

To deal successfully with critical situations, it is inevitable for all IRS components to have all the necessary information at their disposal. It is often not trivial because the information used in emergency management can have three basic characteristics or dimensions: *time*, *space* and *aggregation*. The time dimension of the data is important

in the crisis situation with dynamic character. It could be contamination spreading or the direction of wind during the fire fighting. This information varies with time so it is a relevant factor in dealing with the crisis situation. Another important aspect of the information is that it is bound to the intervention place. It is only the limited area around the intervention place that is important and it can be defined according to the character of the crisis. The last dimension of information relevant to dealing with a crisis situation is aggregation. The data is provided to the intervention units in aggregated form, for example as specific maps or map layers. However, they contain also specific data sets that could be irrelevant to the character of a particular intervention location or to the crisis itself. The way to avoid unnecessary information is to use adaptive mapping [3].

4.4 Psychological Aspects

There is a new belief that even despite the devastating impact of disasters, substantial lack of resources, and general chaos, there is still a possibility of carrying out some actions that will serve in maintaining at least the basic integrity of the human society and its dignity. Psychological aspects are usually very important for dealing with crises. All activities of crisis management are performed under substantial time and psychological pressure. Intervention commanders work and make decisions in fear of their possible failure. They often have insufficient and inaccurate information at their own disposal during chaotic development of the situation. Other problems arise from lack of necessary resources, like working tools and necessary equipment or integrated rescue system resources. The basic requirements of life may sometimes be restricted under the influence of all these factors.

4.5 Using of Standards

Unified Modelling Language (UML) is a standardized modelling language used in the field of software engineering. Two diagrams are suitable for process modelling. 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.

Business Process Modelling Notation (BPMN) provides a notation that is 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.

Web Services Business Process Execution Language (WS-BPEL) defines a model and a grammar for describing the behaviour of a business process based on interactions between the process and its partners. The WS-BPEL process defines how multiple service interactions with these partners are coordinated to achieve a business goal, as well as the state and the logic necessary for this coordination.

5 Conclusions

The primary contribution of this paper is the innovative, process-oriented methodology. The methodology is described in terms of phases, user roles and work products. The paper also describes the set of recommendations, which should be applied when methodology is used on emergency management processes. Recommendations are based on practical experiences with solving of the research plan called *Dynamic Geovisualisation in Crises Management* [3] [4]. The research plan also illustrates the practical use of the methodology in real situations, for example in accidents with dangerous substances.

It is appropriate to emphasis on adequate software support during the methodology use. This support is provided by *Business Process Management Suite* (BPMS), where different tools support different methodology phases. In case of a comprehensive emergency management system it is necessary to take the close interoperability to GIS or other operational systems used by the IRS into account. Therefore it is recommended to add the global architecture which will illustrate the overall deployment of the system based on business processes.

The subsequent objective of this research is to define in detail the methodology phases in terms of individual tasks and their links to each other. This is related to the assignment of responsibilities for these tasks. Similarly, detailed description of the role associated with implementing the methodology in terms of ICT and EM is needed. The final aim is to describe in detail the tasks inputs and outputs in terms of work products and determine whether all information is available at the right time.

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