RESEARCH PAPERS
FACULTY OF MATERIALS SCIENCE AND TECHNOLOGY IN TRNAVA
SLOVAK UNIVERSITY OF TECHNOLOGY IN BRATISLAVA

2010 Number 28

ROLE OF PROCESS MODELS IN SAFETY MANAGEMENT

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Abstract

Management is a type of human activity that establishes and ensures the system functions. The process models and project models are currently used for management support. Main aim of the process model is to describe the possible development tendencies as a consequence of certain phenomenon and to define functions and role of functions. The process models enable to compile procedures and scenarios for the situations that have similar features. They are suitable for planning, response and renovation. In this paper, we present the risk management model used at present in professional practice, two simple models from daily practice and the evaluation of process models for crisis management.

Key words

management, risk, safety, model

Introduction

Life, health, security and a chance of development are important for each human. In integral sense, the safety is a set of measures and activities aimed at conservation, protection and sustainable development of all protected interests. Basic protected interests are the human lives, health and security, property and welfare, environment, technologies and the infrastructures facilitating the human life [1]. In concord with proclamation of the EU, the UN and other world organisations and with professional knowledge, it is necessary to ensure the safe community, safe region, safe state, safe Europe and safe world in order to conserve sustainable development of human society.

With regard to the present findings, the safety management of territory directed to sustainable development concentrates on:

- preceding the disasters if possible,

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- removing the causes of origination of severe disaster impacts or at least reduction of their frequency of occurrence,
- mitigation of unacceptable disaster impacts by preventive measures and activities, preparedness, optimal defeating the disaster impacts and induced critical situations (i.e. shortening the emergency situation duration to acceptable level),
- ensuring the territory renovation after disasters and starting the further development.

Strategic proactive management and its tools are used to hit this target there.

Selected Tools Supporting the Management

The management is a type of human activity that establishes and ensures the given system functions. It is a conscious way of applying the theoretical and practical knowledge of top managers directed to identification and diagnosis of the problems and targets in a given system, matters of defeating the problems, determination of procedures for required targets reaching and on implementation of procedures connected with supervisory mechanisms directed to the aim in order that required targets might be optimally reached. The tasks are to diagnose each problem, to decide rationally, to realise decision-making in given real conditions.

It is evident that the management is successful only if it is based on professional knowledge and experience. To obtain required knowledge and experience, we must permanently collect, process and verify data, perform qualified assessment that can only be done by qualified and experienced specialists. These demands can be met only on the state level. Therefore, in developed countries, there are different organisational structures, dependent on the state administration organisation that monitor safety, disasters etc. and prepare grounds for decision making and strategic development of land.

The management consists of making individual decision. It consists of the following steps:
- assembling and processing the information with respect to the fact that processing must be adequate to particular problem (i.e. that data processing methods for needs of safety management must respect that big disasters with devastative impacts occur rarely, and therefore, the procedures respecting the great numbers law, i.e. algorithms based on extreme or marginal estimations must be used,
- recognition of solution variants,
- searching for optimal problem solution,
- own decision making.

To make the decision making objective and qualified, it is necessary:
- to have a sufficient number of information, its objective processing and cognition of suitable reactions,
- permanent reaction to an access to new findings,
- to understand the solved problems in connection to their vicinity and in their internal structure,
- to combine the suitable knowledge, experience and new information in order to obtain practical way of problem solution,
- credible data assessment.

In decision making, it is necessary to consider:

- the judgement of present conditions and present decision making from the viewpoint of a future development,
- the qualitative factors and strategies of different participants,
- the fact that the future is multidimensional and indefinite,
- the fact that each system must be investigated both globally and systemically,
- the fact that information and strategies are not neutral but tendentious,
- that more approaches complement each other,
- the fact that there are prejudices against the strategies and humans which should be prohibited.

Decision making must be objective and qualified. From the viewpoint of the knowledge that might be decisive in systemic concept, decision making can be classified as:

- standard; all is known and standard procedures of solution are also known,
- well structured; there is a clear and quantitatively described structure of problem in systemic concept and the optimizing methods may be used,
- weekly structured; i.e. there are not only uncertainties but also unclearness in case of several elements of structure of judged system. To put under control, the methods of system analysis that join exact mathematical methods with normalised quantitative considerations (i.e. heuristic methods) must be used. Decision making heuristic methods are the methods of decision making analysis that are usually divided into:
  - decision making tree (process model),
  - decision making matrix.

  Assessment of process models is often performed by the Delphi method [2] and the assessment of decision making matrixes is performed by the way described in appropriate handbooks , e.g. [3];
- non-structured; i.e. there are uncertainties regarding many elements, links and flows of the judged system. Their solution is possible by the expert methods. Expert methods simulate intellectual procedures of specialists. They are based on the scenario of process in which a decision maker is directed to solve partial problems of decision making in certain logic procedure of considerations and activities connected with generation and assessment of different variants of solution of a given problem. Expert systems can be classified as diagnose and generative (designing) ones [4, 5]. To support decision making, case studies are processed [6] that use qualitative data in a way enabling to obtain the idea of frequent solution of problem in certain context determined by given conditions in the evaluated system and its vicinity.

When selecting a method of decision making, it is necessary to respect the nature of the solved problem, determine aims of solution, criteria for solution and possibilities of collecting the necessary input information. In a domain of land safety management, it is necessary to realise that the majority of problems is connected with uncertainties and unclearness induced by fact that the human system has been continuously developing in permanently changing outer medium, and that to fulfil the safety management targets, it is necessary to choose a good strategy for ensuring the human system security and sustainable development.

Strategy is a set of rules for decision making under the conditions of uncertainties and unclearness. The development of strategic management accompanied by formation of effective tools started in the second half of the 20th century, when methods of operating

analysis based on the creation and assessment of variants of possible evolutionary tendencies of system were processed. In the 70s, the process approach was worked out which was in the 80s linked with the systemic approach that represented net interface and complex view on a given reality.

To produce variants of processes, the methods based either on the estimation or on the mathematic modelling are used today. When selecting a method for decision making, it is necessary to respect the nature of the solved problem, determine aims of solution, solution criteria and possibilities of collection of necessary input information. The first group of methods comprises the methods of analogy, brainstorming, brain writing, panel discussion, Delphi method, Gordon methods (technique of creative thinking), application of fuzzy sets, and application of fractals [7]. The methods based on mathematical modelling are based on the time series processing. Excessive exactitude in the construction of exact models often leads to overestimation of theoretical viewpoints and to non-respecting the real needs and possibilities of future users. Pragmatic approach, based on the analysis of real situation and on building a model suitable just for it, depends on the methodology of model compilation – objectivity, non-prejudiced and comprehensiveness of data, capabilities and competence of professionals.

There is always an effort to divide the problem into a hierarchy of sub problems of different orders, i.e. structure the problem. Problem structuring has two dimensions, namely the problem decomposition and the level of abstraction of problem representation.

For management support, the process models and the project models are elaborated at present [8]. Main aim of the process model is to depict possible development tendencies as a consequence of certain phenomena, pertinently to demark functions and role of functions. The application of process model is suitable for repeated activities that can be structured and consecutively described. The typical case is the production enterprise with a serial production. The application of project approach is conversely suitable for unique projects, e.g. big buildings, software development etc. Individual projects allocate in life cycle own and external sources according to momentary need. The project approach has always higher uncertainty and is worse described by tree model [8].

Process Models

Fundamental for process management is the elaboration of process models. Modelling is a specific sort of cognition of reality that is around us. It is an efficient activity that we have been using in case of complex process / activity / object etc., when we want to investigate only certain matters, i.e. the existing reality is simplified or sometimes only reduced or magnified. During the modelling, we elaborate the model of identified reality (mathematical, thought, oral, graphical, physical (imitation)) for defined purpose, that (following from condition of isomorphic or homomorphism representation) may give great evidence capability that is only valid in the extent of reality for each model. Mathematical and physical models come from analogies among physical quantities. The model compiled according to principles for physical model has the same physical nature as the object. The model compiled according to principles for mathematical model has a different nature, but its function is perceived by the set of equations identical with the set of equations describing the items of original.

Mathematical models we can classified according to the different viewpoints. According to the character of parameters and deciding variables [9], the models are divided into:

1. Deterministic models, i.e. models in which all parameters are fixed deterministic values and in which there are only deterministic quantities and relations, i.e. nor uncertainties neither unclearness are allowed.
2. Stochastic models, i.e. such models in which at least one parameter that is a random quantity occurred and there is no unclearness (i.e. deviations from reality connected with blunder error at collection or at interpretation of data, measurement or with lack of data or with non-linearity of process or with intentional or non-intentional neglecting sure actions or events). It means that at least one decisive variable in model is a random quantity. Uncertainties connected with this random quantity (or with these random quantities) may be assessed by the methods of mathematic statistics. Probability distribution of random variables in the model is known (in practice this distribution is deduced either from logic – theoretical considerations or by methods by mathematical statistics or by expert methods).
3. Models with unclearness are sometimes called strategic, i.e. the ones when there is at least one quantity that is random, but its distribution (unlike stochastic models) is not known and cannot be determined by logic – theoretical considerations or by the methods of mathematical statistics (usually owing to low number of events) or by expert methods. We usually say that we only know bottom and top limits of these quantities in these models.

Modelling is one of the methods used for solving the tasks of practice if inputs and outputs are known. Terminologically, clean-out models are e.g. the models:
- fuzzy multi-criteria,
- conceptual or qualitative,
- quantitative,
- dynamic and simulative,
- ecological effectiveness.

Chosen typology of continuous discrete decision models leads to classification into two basic groups, namely multi-criteria discrete models and multi-purpose continuous optimising models. The other possible classification is according to so called degree or “softness” or “hardness”, i.e. according to completeness and accuracy of input information. There are models of certain softness type (SOFT) and certain hardness type (HARD).

Process models belong to the category of qualitative models on the basis of process analysis and graphical representation. In the 90s of last century, many different technologies have been developed. The most popular methods were the OMT (Rumbaugh), the OOAD (Booch) and the OOSE (Jacobson). Each of these methods had its own value and advantages. The OMT emphasizes the analysis, the OOAD proposal and the OOSE behaviour analysis. The methodologies have been converged; however, they have been using their own symbols. Using the different symbols caused the problems on market, since one symbol was interpreted differently by various people. This war of methods was terminated by UML (Unified Modelling Language) that represents the unification of Booche, Rumbaugh and object symbols of many others. UML is a fundament/standard in the domain of object oriented analyses and of proposals based on experience of professionals [10].

Process model supported by qualitative tool enables to describe actual conditions, to propose new processes or to optimise existing processes, to reveal unnecessary or inefficient

processes, to simulate and to evaluate possible impacts of changes before their implementation. From the viewpoint of formalised process analysis, process models represent sophisticated tools in which pure graphic representation may be misguided and it may mean unacceptable simplification of judged system.

Process Models Supporting the Safety Management

As an example, we will show the risk management model that has been used at present in professional practice, two simple models from daily practice and the evaluation of process models for crisis management.

Risk Management Model

The risk management model leads the project medium to proactive continuous risk management. The risk management process according to this model comprises five steps – identification, analysis, countermeasure planning, monitoring and own management. Each risk goes through these steps at least once.

In the first step, the source of risk, character of possible failure of object, operational and commercial connections are determined. In the second step, the probability and impacts (for calculation and mutual comparison of risk) are determined. In the third step, countermeasures leading to risk reduction, risk mitigation and transfer of risk to somebody else are defined. In the forth step, information on risk and change of its elements in time is obtained. In the fifth step, planned actions as reactions to appurtenant changes are performed.

Outputs from risk management process are the following:

1. ***Risk assessment document*** – it includes all information on appurtenant risk.
2. ***Top risks list*** – it contains list of selected risks, the solution of which has the highest demands on sources and time.
3. ***Retired risk list*** - it serves as historical reference to future decision making.

Process Models Derived for Practice

The following figures (Fig. 1 and Fig. 2) show the examples from practice. The first one describes the processes necessary to ensure the security and sustainable development of land in the case of traffic accident of tanker. The second one describes the processes that can cause the destruction of boiler.

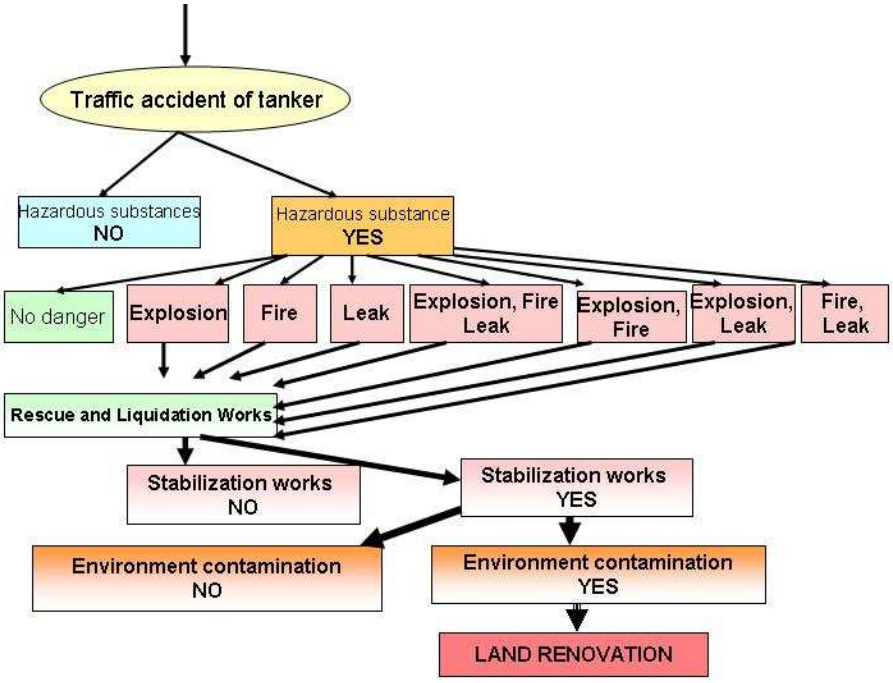

Fig. 1 *The process model describing the tanker traffic accident*

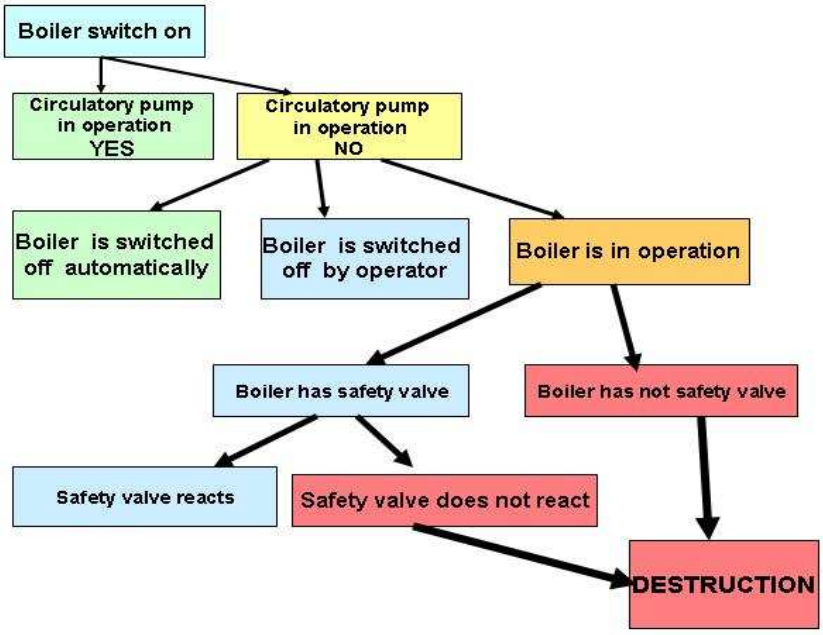

Fig. 2 *The process model describing the boiler destruction*

Process Models Supporting the Crisis Management

On the crisis management portal of public administration [11]**,** there is the use of process models for crisis management. Possibilities of standardisation, simulation, processing and

evaluation of process models for individual domains of crisis management are described there. the uses of individual models for crisis management in practice, the sequences of works at life cycle of extra ordinary event or crisis situation with regard to individual specifications of domains in which they originate are shown. Interpretation of the EU and NATO standards, compatibility with legislative and other favourable properties for domain of teaching, preparation and training of individual components participating in crisis management are described. One can find there a description of procedures and conditions for connection of process models for crisis management with used and originating tools for crisis management support, including the links to the IT.

Conclusion

Each process is a sequence of phenomena or activities in space and time, in which we can distinguish inputs and outputs. Inside of each process, there are usually parallel but distinct sub processes. Each of sub processes is bound up to certain element in space or to certain group of elements in process under account. The process model is a representation of certain process directed to a certain target. As targets are not the same in practice, there are several process models for one process.

The process models enable to compile procedures and scenarios for certain situations that have certain similar features. They are suitable for planning, response and renovation. They are constructed according to real needs. Results of process model application are the norms, standards, security, emergency, accident, crisis, continuity and other plans, disaster scenarios, response scenarios, renovation scenarios etc.

In management domain, namely in the planning, it is possible to use the process models reflecting the reality type for certain, strictly limited type of activities. With regard to the above mentioned theory, each process model must be tested whether a given reality corresponds to model assumptions. If yes, it is possible to use this model and vice versa. With regard to the multiplicity and variety of reality, it is not sufficient to use only deterministic and stochastic models, but in the case of higher demands on accuracy, it is necessary to apply the models with unclearness in which unclearness is eliminated by expert methods or by case study methodology [6].

The domain of security, emergency, accident and crisis planning are the domains in which it is necessary to consider the origination of unforeseeable phenomena (human error at decision making, lack of necessary sources of all kinds, occurrence of meteorological conditions, unusual combination of phenomena etc.), it is the domain in which it is necessary to use the process models based on the models with unclearness because:

- deterministic models that are conservative, i.e. that are very expensive,
- stochastic models do not perceive possible situations because they are too simplified.

Process models based on deterministic approach have been used at sitting, designing, building and processing the technologies and objects because they ensure the highest level of safety with regard to the present knowledge and experience.

Process models based on stochastic approach have been most often used in inspection activities and routine management of safety of certain processes or objects.

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