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MODELING AND EVALUATION OF PROJECT RISKS IN MULTI-PROJECT ENVIRONMENT

Vasyl Lytvyn, Ihor Rishnyak
Lviv Polytechnic National University, ISN Department

Abstract. *The article describes risk model of the project that operates in the multi-project environment. A formal assessment of project risks was presented. Approaches to risk assessment on various criteria are given.*

Keywords: project management, project risk, risk model, multi-project environment, risk assessment

MODELOWANIE I OCENA RYZYKA PROJEKTÓW W ŚRODOWISKU WIELOPROJEKTOWYM

Streszczenie. *W artykule opisano model ryzyka projektu, który funkcjonuje w środowisku wieloprojektowym. Przedstawiono formalną ocenę ryzyka projektów. Rozpatrzono podejścia do oceny ryzyka wg. różnych kryteriów.*

Słowa kluczowe: zarządzanie projektem, ryzyko projektu, model ryzyka, środowisko wieloprojektowe, ocena ryzyka

Introduction

The goal is to identify risk modeling algorithm for optimal decision making, adequate specific situation. This aspect can be seen as static and dynamic models, which in turn describe deterministic or stochastic informational situation accordingly. However, with the project activity, when the decision affects a large number of factors, it is advisable to pay attention to dynamic models only.

Dynamic models suggest the presence of stochastic uncertainty and allow decision making in a shortage of information. Algorithm for dynamic model must include planned and adaptive parts. Adaptive approach involves an analysis of the planned phases, a quantitative assessment of reliability and risk rejection of actual values of the target. The algorithm of optimal decision making by a person deciding (PD) in this situation would be as follows (Fig. 1).

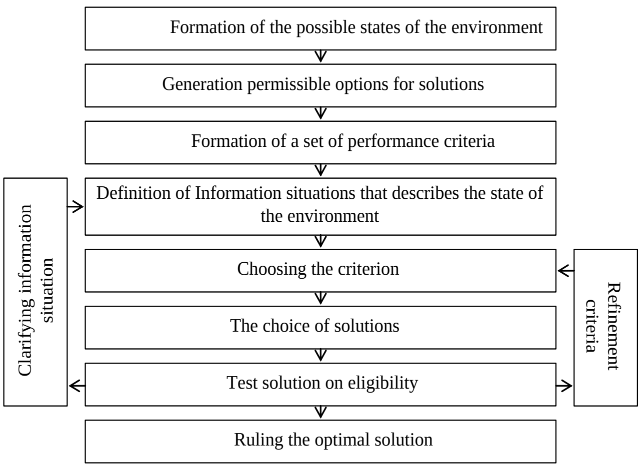

Fig. 1. Block diagram of dynamic risk model [1]

1. Formal model of risk

Coming from definition of the risk given in [3], the risk r depends on the following factors: decision which is accepted a, undefined situation s, in the conditions of which decision is made, and the expected result d_O: $r = < a, s, d_O >$

We will consider correlation between these factors.

Let's assume that S is set of all possible situations; A is set of all possible decisions; D is set of all possible results. If in the situation $s \in S$ decision $a \in A$ is made, then this decision leads to the result $d \in D$, which essentially is the value of reflection Ψ:

$$\Psi : S \times A \to D$$

Thus on the set of results D such an order or relation of advantage is set, that for any pair of results $d_1, d_2 \in D$ we can with confidence say whether d_1 takes advantage over d_2, or vice versa, d_2 takes advantage above d_1, or they are equivalent.

If any decision $a \in A$ causes the concrete expected result $d_O \in D$, then for any pair of decisions $a_1, a_2 \in A$ it would be possible to choose the best decision according to the expected result. But in reality except the decision, the result is also influenced by the vagueness of situation in the conditions under which the decision is made. Consequently there is the risk, that at decision making $a \in A$ in the situation $s \in S$ the achieved result d will differ from the expected one: $\forall d, d_O \in D : d \neq d_O$ [1].

The situation S appears as definite composition of the state of a multi-project environment (MPE) V and the state of project W, that are fixed in the definite moment of time $t \in T$ [2, 4].

$$S = \{T; V; W\}$$

We will describe constituents V and W as the dynamic systems. We will represent their models as well-organized sets.

In particular for project status:

$$< T; W; X; Y; Q; H >$$

where: T - set of moments of time; W – set of the states of project, X – set of input factors; Y – set of output factors; Q – operator of transitions, which reflects the mechanism of changes of the project state upon condition of external and internal indignations; H – operator of outputs, which describes the mechanism of forming of output factors as reaction to external and internal indignations;

Operators Q and H realize the reflection :

$$Q : T \times X \times W \to W$$
$$H : T \times X \times W \to Y$$

In Fig. 2 shows the structure of relations in the system «MPE-project- PD».

Factors influencing the project is the composition of several factors: $X = X' \times X'' \times A$.

They are formed from control (predicted) MPE action for the project $X' = (x'_1, x'_2, x'_i)$, uncertain impacts on project $X'' = (x''_1, x''_2, x''_j)$, which can be active or passive, and making $A = (a_1, a_2, a_l)$, filed by the PD.

Under the active factors of influence on the external environment we imply conscious purposeful activity aimed at achievement of concrete changes in an external environment with the subsequent mediated influence on the state of project. The passive factors of influence are the natural changes of background of external environment. Influence of passive factors can be modelled by means of probabilistic methods which are fully described in literature. Influence of active components is determined by means of gaming simulation and strategy, taking into account the social, psychological, emotional and other personal aspects of the opponent. Feedback sets of factors influence the output $Y = (y_1, y_2, y_k)$, which are produced during the project life cycle, the state of the MPE and solutions PD.

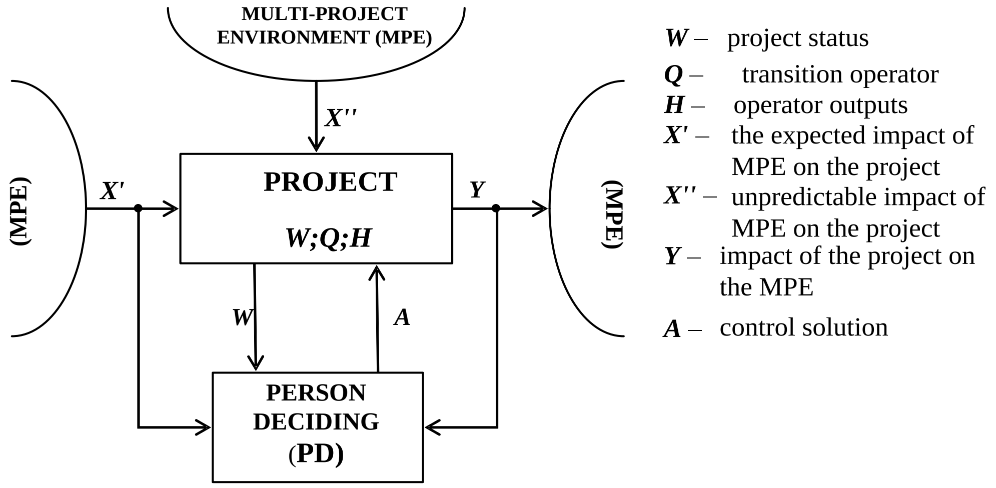

Fig. 2. The structure of relations in the system « MPE-project- PD »

2. Risk assessment

Risk assessment, in respect of which some decisions are made, depends on the certainty or uncertainty of the situation and the importance of the losses that arise in this situation [1, 3, 4, 5, 6].

The importance of losses is represented by two variables: the size of certain losses $g \in G$ (G - set of all possible losses), which is actually the difference between the result and the expected value and θ, which characterizes the individual's attitude to risk. The uncertainty of the situation depends on the uncertainty of parameters or factors that create this situation of uncertainty and the value of each parameter in particular. So the first step in risk assessment is the selection of the parameters defining the situation , change of the values of which radically changes the situation and influences the decision. This problem is usually solved by the method of analogy with the assistance of experts. The next step is solving uncertainty values of the assigned parameters. This problem should be addressed with the use of probabilistic methods and the factor of the potential situation should be included in the formalized description of the risk assessment $p \in P$ (P - probability set of situations).

Formalized risk assessment model will be presented as [1, 6]:

$$O = \{P;G;\theta\},$$

where: O - risk assessment; P - probability of the set of situations; G - set of possible losses; θ - individual attitude to risk.

We consider two approaches to risk assessment: the two and the three criteria. And for default values of these criteria we will use qualitative parameters (a situation that occurs most often). One specifies the metrics and quality of objectives and the criteria will determine θ (individual's attitude to risk).

3. Evaluation according to the two criteria

Use assessment of thetwo factors: the probability of the risk event occurrence and the magnitude of losses due to occurrence of the event. In general it can be presented by the formula:

RISK = [probability events] * [price losses]

First, set the appropriate scale and metric. For example:

- Subjective scale of probability of risk events:
  - ***A*** - an event almost never happens;
  - ***B*** - event is rare;
  - ***C*** - the likelihood of the event 50/50;
  - ***D*** - an event likely to happen;
  - ***E*** - an event almost certain to occur.
- Subjective severity scale losses:
  - *Negligible* - impact events can be neglected;
  - *Minor* - a minor impact;
  - *Moderate* - moderate impact;
  - *Serious* - impact of the serious consequences associated with significant costs;
  - *Critical* - effect leads to critical consequences , can not solve the problem.
- Subjective scale of risk:
  - low risk (LR);
  - medium risk (MR);
  - high risk (HR).

The risk associated with a specific event, determined as (see Table 1).

Table 1. Defining risk based on the two criteria

		SERIOUSNESS OF THE CONSEQUENCES OF				
		Negligible	*Minor*	*Moderate*	*Serious*	*Critical*
CHANCE EVENTS	***A***	LR	LR	LR	MR	MR
	B	LR	LR	MR	MR	HR
	C	LR	MR	MR	MR	HR
	D	MR	MR	MR	HR	HR
	E	MR	HR	HR	HR	HR

Scale of risk factors can be defined differently and have a different number of gradations determined by individual's attitudes towards risk. However, it is important for the value scales to be clearly defined and equally perceived by all the participants of the peer review procedures.

4. Evaluation of the three criteria

Evaluation is carried out according to the following criteria: a threat is a set of conditions and factors that may have negative consequences, vulnerability is a definite weakness of the protection system, which makes it possible to implement the threat, the value of losses as a result of the threat.

In this case, the probability of the event depends on the level (probability) of the two components (threat and vulnerability) and therefore the risk assessment formula for the two criteria is transformed as follows:

RISK = [probability of threat] * [probability vulnerability] * [price losses]

For example, to determine the scale and grading criteria as follows:

- The level of threat and vulnerability levels:
  low (L);
  medium (M);
  high (H).
- Subjective severity scale losses in the previous example:
  Negligible - impact events can be neglected;
  Minor - a minor impact;
  Moderate - moderate impact;
  Serious - impact of the serious consequences associated with significant costs;
  Critical – the effect leads to critical consequences , can not solve the problem.
- Determine the risk weight on a scale from 0 to 8 with defined risk levels :
  0 - no risk,
  1 - the risk is extremely small,
  ...,
  ...,
  ...,
  8 - the risk is extremely high.

Then the matrix risk assessment will be as follows (see Table 2).

Table 2. Defining risk based on the three criteria

SEVERITY LOSSES	*THREAT LEVEL*								
	L			M			H		
	POSURE			*POSURE*			*POSURE*		
	L	M	H	L	M	H	L	M	H
Negligible	0	1	2	1	2	3	2	3	4
Minor	1	2	3	2	3	4	3	4	5
Moderate	2	3	4	3	4	5	4	5	6
Serious	3	4	5	4	5	6	5	6	7
Critical	4	5	6	5	6	7	6	7	8

To assess the level of threat and vulnerability different methods are used, which are based on expert opinions, statistical data, taking into account factors that affect the level of threat and vulnerability. The most effective method is complex - expert assessment based on the previously collected statistics and factors influencing the level of threat and vulnerability.

5. Quantitative risk assessment

Quantitative risk assessment of the project can be presented as follows [4]:

$$R = \sum_{i=1}^{m} w_i \cdot p_i$$

where: R - risk; m-number of risk factors; p_i - probability of the i-th risk factor, as measured in fractions of a unit; w_i - the proportion of the significance of i-th risk factor in the totality of the factors adopted by the unit.

First, we determined the proportion of risk factors with the lowest priority as follows:

$$w_{\min} = 2 / [m(f+1)]$$

where f - the priority of the first factor related to the m-th;

The share of other risk factors is given by:

$$w_i = w_{\min} [(m-1) \cdot f + i - 1] / (m-1)$$

The significance of the i-th risk factor is determined on the basis of expert opinion. In this case, a number of experts is chosen. Based on the accepted grading system, experts assign priority (importance) of each risk factor in points. Experts determine the probability of each group and individual factors in the adopted notation.

Probabilities are set by law or determined by the empirical distribution for each possible value (value range) of a random variable. In the first case, the uncertainty is modeled according to specific mathematical principles and the second is simply stated on the grounds of subjective assessments.

6. Conclusions

In the majority of cases, in order to set the probability of the set of elements of events an analytical method is used, that is giving the law of the distribution of the random variable . Among its advantages is the absolute probability of formalization and ordering of certain values of a random variable depending on the two main factors that are taken into account when modeling uncertainty: dispersion of possible values of a random variable from its expected value and the deviation of a random variable values from the expected value. When asking probabilities analytically, the choice of the distribution of the random variable is crucial.

The risk is a difficult objective- subjective category, influenced by both external circumstances and internal parameters of the project and the subjective perception of the risk of a person who makes a decision.

Depending on the specific conditions , the availability of information and the goals of the project risk can vary significantly . Therefore, the risk estimates are useful methods, sensitivity analysis, alternative methods of decision making. Using on the obtained results we can achieve a corresponding prediction, compare it with the intended purpose of and shape administering information and the necessary action.

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Ph.D. Lytvyn Vasyl
e-mail: vasyl17.lytvyn@gmail.com

Associate professor of Information Systems Institute of Computer Science and Information Technology at National University "Lviv Polytechnic".
Research interests: modeling the behavior of intelligent agents, ontology development methods, Intelligent Decision Support Systems.

M.Sc. Rishnyak Ihor
e-mail: rishnyak.iv@gmail.com

Senior lecturer of Department of Information Systems Institute of Computer Science and Information Technology at National University "Lviv Polytechnic".
Research interests: Project management, Project management, Intelligent Decision Support Systems.

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