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INTELLIGENT MODEL OF CHOOSING THE OPTIMAL RISK EVENTS MANAGEMENT STRATEGY: THREATS AND OPPORTUNITIES

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Annotation. The study is devoted to the formation of an intelligent model for choosing and applying the optimal strategy for managing risk events, both threats and opportunities, of modern small IT projects with limited resources and implicit or uncertain influencing factors. The proposed model is built taking into account the decomposition of the process into three sub-processes, for which the criteria, target function, graphs of the development of events are proposed, taking into account the synergy of possible threats and opportunities. It is formed for the purpose of proactive management of risk events and is able to overcome uncertainty due to possible forecasting of future states for cases of a priori uncertainty and lack of information about possible consequences. The distribution of threats and opportunities is applied in the form of a developed unique target model with introduced weights of threats and opportunities based on expert assessments, taking into account the experience of experts from previous typical projects. Theoretical recommendations and risk management standards from the most common project management standards are taken into account. The developed intellectual model takes into account both the cost of implementing strategies and the total costs of their implementation.

Keywords: intelligent model, risk management, risk, treat, opportunity, risk response, IT-project, decision-making methods.

Introduction

The development of information technologies and the use of artificial intelligence methods to solve a wide range of human activity problems have significantly improved the quality of life and labor productivity.

Despite the fact that the effectiveness of solutions to most information processing tasks, such as pattern recognition, feature classification, is increasing, and artificial intelligence is successfully used to find solutions, there are still tasks that are left to the decision-maker, typically as to the project manager. This applies to tasks in which there is a large a priori uncertainty and no information about possible consequences. The class of such tasks can include forecasting in conditions of incomplete data, risk management, design processes that are associated with the development of fundamentally new samples and that do not use design patterns and templates. But as practice shows, for most human decisions it is also impossible to accurately determine or evaluate the consequences. We can only assume that certain solutions will lead to the best result. It is also difficult to predict the consequences of not taking risks into account, or not using opportunities, since there are no methods and approaches that would allow it to be done with a sufficient degree of reliability. Therefore, the creation of decision-making methods that are related to risk management, both as threats to activity and as opportunities for development, are extremely important for practice and an interesting object of research for science. Considering this, there is an urgent need for the development of artificial intelligence methods, which, together with high speed and accuracy of calculations, would allow to quickly assess the situation, would be able to respond to changes in the surrounding environment, would allow to distinguish the main and discard the secondary, to correlate assessments that contain contradictions capable of overcoming uncertainty due to the possible prediction of any future states [1].

Statement of the problem

The proposed study is devoted to risk management in IT projects. As it turned out, for small IT projects, when developing fundamentally new software products, it is very difficult to find statistical regularities in determining risks and assessing their possible consequences. Existing risk classification methods and risk management strategies are based on the assumption that all risks are only threats, and management strategies are based on the principle of responding to a risk that has already occurred. CMMI for Development is an integrated set of best practices that improve productivity and key capabilities for organizations that develop products, components, and services [2]. This model contains a risk management domain, which is defined as an one of the extended project management domains. Any components of the risk management area in CMMI for Development do not cover opportunity management and are dedicated only to preparing the organization for negative risks only that is called threats [3]. The Japanese standard Guidebook of Project and Program Management for Enterprise Innovation (P2M) describes risk management from a domain management perspective. Domain management is the management of specific functions or areas of project management knowledge. According to the P2M standard, the implementation of risk management in projects leads to the control of many risk events and can lead to the realization of an opportunity that provides better results and development [4]. It can be seen that Opportunity Management is poorly represented from the point of view of the P2M standard, while the emphasis is mainly on the prediction of negative risks, their control and preventive measures or actions [5]. For risk management in IT projects, methods of predicting the occurrence of risk are very poorly involved, therefore there are no adequate response strategies, there are also completely no strategies that are built on the principles of opportunity management development.

This study examines IT projects in which it is difficult to determine the probability of risk occurrence and there is no information about the consequences that may arise from the implementation of risky opportunities.

The main research questions in this direction include:

1. Creation of risk identification methods for both threats and opportunities. Determination of classification features and assignment of a risk event to the appropriate category.

2. Quantitative and qualitative risk analysis with determination of the degree of influence. Determination of the criteria by which the analysis of the risk event is carried out. Determination of criteria for mutual influence (synergy) of risk events.

3. Bringing risk assessment criteria to a single measurement scale.

4. Determination of the purpose of risk management, which will allow formulating behavioral strategies for risk management. Determination of possible scenarios of response to a risk event in accordance with the management goal.

5. Selection of the optimal behavior strategy for leveling the impact of a threat or development of an opportunity.

Analysis of recent research and publications

The modern market of software and intelligent models is characterized by large standardized management solutions for fairly big typical projects. One of the titans of project management software is MS Project, but it should be considered the recently developed Microsoft Dynamics Project Operations system, which includes a more modern and broader set of modules and offers the visibility, collaboration and flexibility needed to succeed in a project-based business. — from potential customers to payments and profits [6]. Of course, such giants of project and business management systems require support, financing and the development of the necessary additional elements. Another software leader, Oracle, also has a Construction Project Management product that connects and synchronizes teams throughout the project lifecycle through planning, project management and collaboration, improving coordination and control to improve efficiency and limit risk across all range of activities [7]. A lot of research and development is done in the scientific sector, where the development of intelligent systems aims to manage narrow links and types of projects [8], [9], [10].

The aim of the study

The increase in the cost of IT projects

encourages the transition to proactive management of a risk event, which is implemented by a strategy based on the assessment of risks, assigning them to the class of threats or opportunities. At the stage of strategy implementation, each strategy is accompanied by costs of available resources. Therefore, the task of balancing the benefit from realizing the opportunity and the costs from the threat with limited available resources can be considered as an optimization task.

The purpose of this study is to construct such an intelligent optimization model that would allow for the selection of the optimal risk management strategy, both threats and opportunities, with limited available resources, and would ensure proactive management of risk events. The components of the risk event management process in the project depend on the project environment precisely in the field of existing resources, see Figure 1, and the optimal use of resources is the basic criterion for optimizing the management strategy [11].

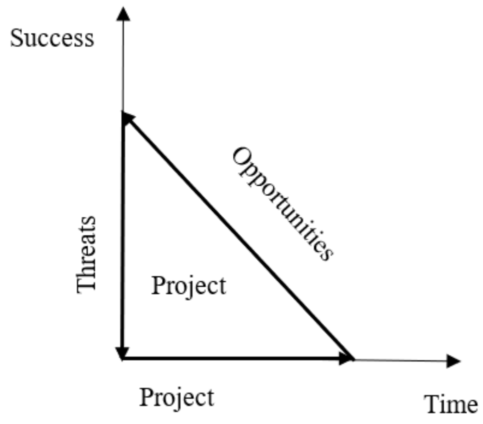

Fig. 1. Components of the risk management process

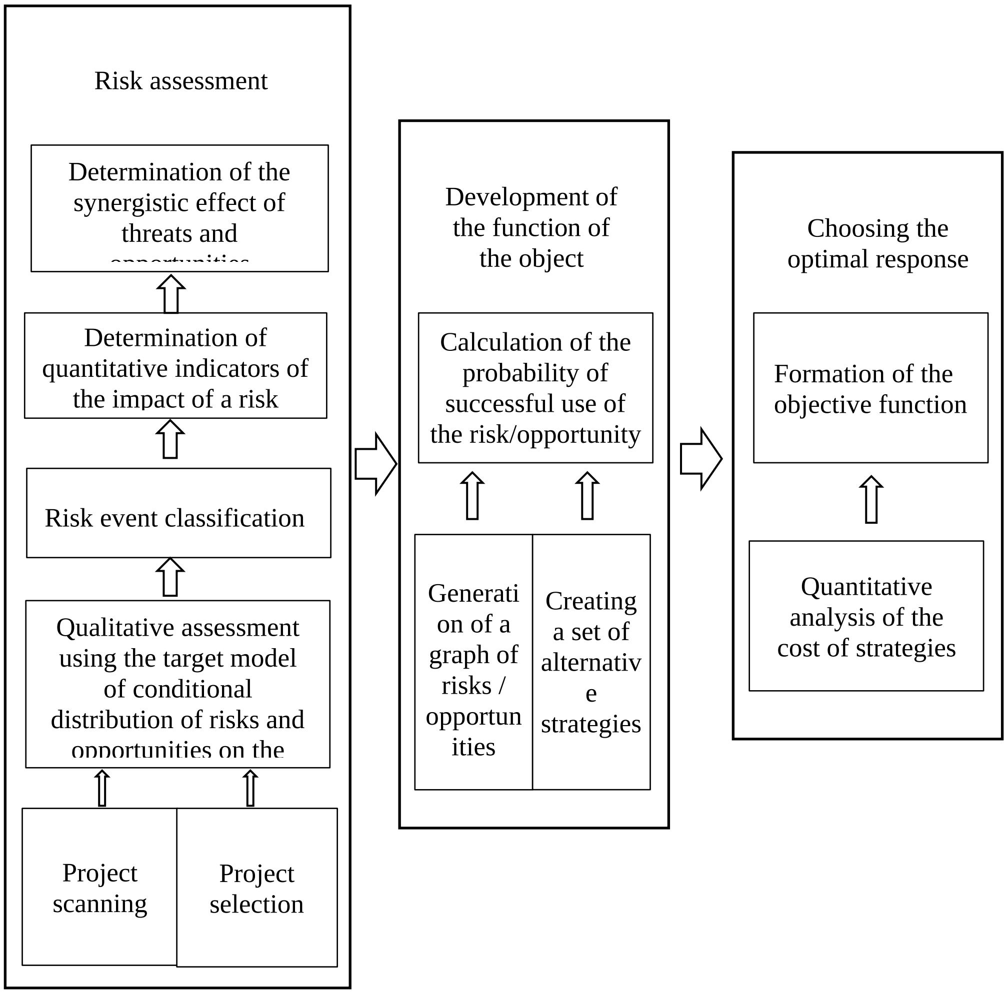

Fig. 2. Scheme of the components of the intelligent model for choosing the optimal strategy for managing risk event

Presentation of the main material

The process of building the optimization model can be divided into three sub-processes, each of which can be implemented by a separate module of the intelligent recommender system. These sub-processes consist in the assessment of the risk event, the selection of optimization criteria and the construction of possible scenarios, the selection of the optimal behavior scenario.

The diagram of the model components and the interaction between them is shown in Figure 2.

Analyzing each of the processes:

1) Risk event assessment. At this stage, risk identification is performed, the qualitative characteristics of the risk event are determined, the event is classified as a threat or opportunity based on these characteristics, the quantitative characteristics of the risk event are determined, the mutual impact of events (synergy) on the development of the project is determined, and the impact criteria are normalized.

2) Construction of the target function and possible scenarios of the development of events.

A Bayesian graph of the possible development of the project (scenario) is built based on historical information for similar events in similar projects, and information about available assets and resources. A set of alternative project development scenarios is being formed. The criterion of optimality is determined, namely, the benefit from the realization of the opportunity and the amount of possible losses in the event of a threat are calculated.

3) Selection of the optimal risk event management strategy. An optimization algorithm is implemented, the optimal solution for the objective function is found with the help of intelligent algorithms, thus the optimal response scenario to a risk event is determined [12]. Taking into account the complex nature of risks, both threats and opportunities, and using a target models approach, each risk, whether a threat or an opportunity, should be ranked and placed in the target model for each project constraint to calculate the overall risk for each project constraint and make a decision on choosing the optimal strategy.

The complex nature of threats and opportunities can be represented by the following formulas

$$D_i = \sum_{i=1}^{n} P_{id} \cdot \left(V_{idb} + V_{idt} + V_{ids} + V_{idq}\right),$$

$$C_i = \sum_{i=1}^{m} P_{ic} \cdot (V_{icb} + V_{ict} + V_{ics} + V_{icq}),$$

where i – a value from 1 to n or m, n – number of threats in the project, D_i – i-th threat in the project, P_{id} – probability of occurrence of the i-th threat from 0 to 1, V_{idb} – an impact value of the i-th threat on the budget from -10 до 0, V_{idt} – an impact value of the i-th threat on time or schedule from -10 to 0, V_{ids}– an impact value of the i-th threat on project scope from -10 to 0, V_{idq} – an impact value of the i-ї threat on quality from -10 to 0; m – number of opportunities in the project, C_i – i-th opportunity in the project, P_{ic}– probability of occurrence of the i-th opportunity from 0 to 1, V_{icb} – an impact value of the i-th opportunity on the budget from 0 to 10, V_{ict} – a value of the i-th impact of the opportunity on the time or schedule from 0 to 10, V_{ics} – a value of the i-th opportunity value on project scope from 0 to 10, V_{icq}– a value of the i-th opportunity impact on project quality from 0 to 10. All P_{id}, P_{ic}, V_{idb}, V_{idt}, V_{ids}, V_{idq}, V_{icb}, V_{ict}, V_{ics}, V_{icq} val ues for threats and opportunities are determined using experts assessments [13].

The relative synergistic effect can be represented in the form of the ratio of the difference between the indicators of income and the planned budget with the total grouped threat and opportunity of the project and the difference between income and the planned budget with the sum of all j-th threats and i-th opportunities of the project. Which is modeled by the following expression:

$$E = \frac{F - S - (\sum_{i=0}^{n} \sum_{j=0}^{m} (\sum_{t2=0}^{T} p_{jt} v_{jt} - \sum_{t1=0}^{T} p_{it} v_{it}))}{F - S - \sum_{t2=0}^{T} \sum_{j=0}^{n} p_{jt} v_{jt} + \sum_{t1=0}^{T} \sum_{i=0}^{n} p_{it} v_{it}} > 1,$$

where F is the expected revenue from the project and S is the project budget. The presented condition model is a positive synergistic effect from managing threats and opportunities at the same time, because the total result from managing risks and threats is higher than from managing threats or risks separately. This hypothesis can be tested on the model of grouping of threats and opportunities depending on various features [14].

A Bayesian graph is constructed to determine possible strategies for the development of a risk event. The Bayesian graph of the development of events (scenario) in its general form is a directed acyclic graph, which can be defined as:

$$BAG = (S, E, A, P),$$

Where S $= \{S_1, S_2, \dots, S_n\}$ — the set of nodes of all attributes of the graph.

E $= \{\dots, E_{ij}, \dots\}$ — the set of all directed edges of a graph where E_{ij} has two terminal nodes E_i and E_j, with S_i being the parent node and S_i being the child node.

A $= \{A_1, A_2, \dots, A_n\}$ determines alternatives for the development of events. $A_1 = 1$ means that the alternative exists, otherwise $A_i = 0$.

P $= \{\mathrm{P}(S_1), \mathrm{P}(S_2), \dots, \mathrm{P}\,(S_n)\}$ is the set of probabilities that a risk event may occur at a given stage. $\mathrm{P}(S_i)$ determines the probability of success in passing the risk event of the attribute node S_i.

Information about available assets and resources is plotted on the Bayesian graph, which allows determining the criterion of optimality. The criterion of optimality is additive and characterizes the benefit from realizing the opportunity and the amount of possible losses in the event of a threat.

Calculation of the probability of occurrence of a risky event

$$\mathrm{P}(S_i) = V \times C \times \mathrm{U},$$

that takes place taking into account the indicators V – speed of impact (the impact of a risk event on a short period of time of the project), C – complexity (characterizes the level of complexity of the consequences of the impact), U – authentication of the risk event as a threat or opportunity, their values are shown in table 1.

A is a set of alternative scenarios of the development of events, denoted as A $= \{A_1, A_2, \dots, A_n\}$, where A_i is each individual scenario of the development of events that can be implemented on the attribute node S_i. A_i = 1 means that the strategy will be implemented, otherwise A_i = 0.

Table 1. Identifiers

Identifier	Level	Value
V	high	1
	medium	0,5
	low	0
C	high	1
	medium	0,5
	low	0
U	threat	1/0
	opportunity	1/0

Implementation of strategies inevitably incurs costs to prevent threats and/or realize opportunities.

The cost can be determined by a set [15]

$$\mathrm{COST} = \{COST_1, COST_2, \dots, COST_n\},$$

where $COST_i$ is the cost of implementing strategy A_i. The cost of each alternative can be defined as

$$COST_i = \omega_i \times value \times 100,$$

where ω_i is the normalized weight of the strategy, its value is measured by the value of the asset. Thus, the total costs of implementing strategies A $= \{A_1, A_2, \dots, A_n\}$ can be determined by the formula:

$$C(A) = \Sigma A_i COST_i, \text{ де } i = 1.$$

The benefit of implementing the S_i attribute capability can be defined as

$$AG(S_i) = \mathrm{P}(S_i) \times value.$$

In addition, the advantage of the attribute in the implementation of the strategy alternative can be defined as

$$AG(S_i|\mathrm{A}) = \mathrm{P}(S_i|\mathrm{A}) \times value.$$

Thus, the implementation of all possible strategies for providing opportunities [16]

$$AG(M) = \Sigma\, S_i \epsilon \, \mathrm{S}\ \mathrm{AG}(S_i|\mathrm{M}).$$

Since, in small IT projects, losses from threats can significantly outweigh benefits from opportunities, and their joint implementation can cause competition in the use of resources, it is advisable to use a cautious approach and use resources sparingly. Thus, we propose to minimize both the benefit from opportunities and the cost of expenses in case of threats [17].

The objective function can be defined

$$\min_{C(A)<B} \delta AG(A) + (1-\delta)C(A)),$$

where δ and $1-\delta$ are the weighting coefficients of the benefit advantage of the opportunity and the cost of preventing the threat, respectively, and $0 \le \delta \le 1$ is the limit of the total cost.

Conclusions

It is proposed to consider the management of risk events for small IT projects as an optimization model that allows you to choose the optimal risk management strategy, for both threats and opportunities, taking into account their synergistic effect, benefits from opportunities and minimizing the costs of threats, and limited available resources in the project. The developed intelligent model takes into account the complex nature of threat and opportunity, which affects the main constraints of the project, which leads to proactive and effective project management. Using the proposed approach will allow dynamic management of non-typical small-scale IT projects that are not provided with adequate support when using standard project management software from world leaders.

The intelligent model provides decomposition of the process into three sub-processes, it takes into account the graphs of the development of events, the synergy of possible threats and opportunities. The choice of the optimal solution is ensured by cost optimization, for which the criteria and the objective function are proposed. The distribution of threats and opportunities is applied in the form of a developed target model with entered weights of threats and opportunities based on expert assessments. Both the cost of implementation of strategies and the total costs of their implementation are taken into account, a careful approach to the economical use of resources is used, which allows balancing the benefit from the winning of the opportunity and the reduction of costs from the threat with limited available resources.

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