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IMPROVING THE EFFICIENCY OF IT-PROJECTS BY MINIMIZING RISK USING METHODS OF FUZZY LOGIC

The article deals with the problems risk management in the development and implementation of IT projects using fuzzy logic. Examples of internal design risks and possible ways of their reduction are reviewed . As a criterion of choice is considered a nine - point grading scale of Saaty . Proposed for determining the most effective use of fuzzy logic project «worst-case method», which is based on the principle of fuzzy intersection Bellman criteria – Zadeh.

Keywords: *risk management IT projects, fuzzy set, fuzzy logic, fuzzy variable, linguistic variable, IT project , management standards IT-projects.*

Introduction

With the development of information technology for many companies, it became apparent that using a variety of automated information systems can improve the profitability of the business. To provide an effective functioning of modern information and communication systems there have been implemented information technology management systems based on the service approach. Evaluation of the IT services efficiency index provided by users is of primary importance in solving the problems of information technology management. IT services improving is impossible without estimating their efficiency [1].

Relevant is the problem of insufficient elaboration of a comprehensive methodological framework and instrumental environment for decision support, ensuring the processes of risk management for it projects innovative organization under uncertainty environment of decision making.

You must use at each stage of the risk management, qualitative and quantitative assessment, integrating different levels of impact of risk on decision making about the implementation of it projects at pre-design stage. Therefore, it is advisable to develop IP that enables the assessment and analysis of risks of it projects, to select the best solution. To perform the procedure for the selection of it projects, especially in complex and unique situations involved experts, consultants, system analysts, who should, based on their subjective views and knowledge in a particular subject area, to identify the advantages and disadvantages of it projects and to assess the implications and consequences of their implementation.

Main body. Information systems based on fuzzy sets and fuzzy logic, called fuzzy systems.

The advantages of fuzzy systems:
– functioning in conditions of uncertainty;
– handling of qualitative and quantitative data;
– the use of expert knowledge in management;
– construction of models of approximate reasoning person;
– the sustainability of the action of various system disturbances.

The disadvantages of fuzzy systems are:
– the absence of a standard method of designing fuzzy systems;
– the inability of mathematical analysis of fuzzy systems existing methods;
– application of fuzzy approach in comparison with probabilistic did not increase the precision of the calculations.

Fuzzy set theory

The main difference between fuzzy set theory [2] from the classical theory of sets clear is that for crisp sets, the result of evaluating the characteristic function can be only two values - 0 or 1, for fuzzy sets is the number of infinite, but is limited to the range from zero to one.

Fuzzy set. Let U is called a universal set of elements which formed the rest of the set, included in this class of problems, for example the set of all integers, the set of all smooth functions, etc. Characteristic function of a set is a function whose values indicate whether an element of the set A:

$$\mu_A(x) = 1, x \in A,$$
$$\mu_A(x) = 0, x \notin A. \tag{1}$$

In the theory of fuzzy sets is the characteristic function is called the membership function and its value is the degree of belonging of an element x to the fuzzy set A.

Project is a complex system planning (financial, technological, institutional, and other) documents containing complex-system model of action aimed at achieving the original goal. IT project involves activities aimed at the creation or use of information technologies.

The main risks, as a rule, characteristic of any project and are delays in project implementation, the excess

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of the cost of non-compliance and quality parameters. However, the main cause of these risks, especially in it

projects, is the unwillingness of the company to such projects.

Table 1

Examples of internal project risks and possible ways of reducing them

Types of risk	Identification	Examples	Actions
Economic	The risk that changes in the company's business is so significant that plan benefits may not be achieved or the initiative may not be implemented	Limitation of potential it investments	Focus on changing service models, limiting the functionality of newly introduced systems are most needed tasks
Organizational	The risk that institutional change can negate the value and benefits of the project	Internal reorganization in connection with the introduction of the new system	Detailed planning of interaction and dissemination of information in the company, reporting
Technological	The risk that the technology does not meet expectations or will not be suitable for obtaining the desired results	The individual products do not provide the necessary productivity, and integration is not provided	Careful analysis and selection of the most suitable products with the use of best practices, priority, integration, development of components and component architecture
The risk of implementation	The risk that the organization will not be able to implement the project within the given time and budget constraints, or the risk that the creation of a workable solution will fail	Inadequate planning of the project, the lack of clear requirements as to plans and timelines	Preventive and ongoing training of staff in project management, management of relations with consumers. Attracting qualified external consultants and partners
The risk of difficulty	The risk of failure in the case that the degree of difficulty is greatly increased because of the project's scope and magnitude of the necessary changes or the number of involved parties	Incomplete consideration of the interests of the business units	The organization of collective management bodies of the project, constant feedback from the users. Compliance with the project management methodology and portfolio investment
Operating	The risk that operating costs of the new system will increase to an unprofitable level	The cost of services to consumers with the new system significantly exceeds the current value	Consistent application of models for assessing total cost of ownership, compared with market prices. A clear link between investment in the project and results to the business.

Risk management is [3], of course, covers the entire lifecycle of the project from preparation to completion, but the most important (especially in contracts with fixed terms and price) will be correct and an "honest" assessment of future risks at the stage of project preparation.

The choice of intelligent information systems

For example, what is known:

$P = \{P_1, P_2, ..., P_k\}$ is a set of projects for the creation of intelligent information systems (IIS);

$G = \{G_1, G_2, ..., G_k\}$ is a set of quantitative and qualitative evaluation criteria.

Multicriteria analysis of alternatives consists in the ordering of the elements of the set P according to the criteria of G. taking into account published data on project management select the following evaluation criteria IIS:

- G_1 - degree of elaboration of the project;
- G_2 - expected effect;
- G_3 - risks;
- G_4 - speed output IIS on the market;
- G_5 - development prospects IIS;
- G_6 - the cost of the project.

Many of the selected criteria is open – it can be completed with regard to requirements for specific information intelligent systems. In addition, each criterion can be considered as a set of specific indicators at a lower level in the hierarchy. For example, risks (G_3) may include legal, financial, reputation risks, risks of loss of competitive advantage through "cloning" risks of changes in legislation, etc.

Most methods of multicriteria analysis converts a vector of individual criteria on which the alternatives are evaluated in scalar integral criterion. With this approach it is difficult to take into account qualitative criteria, which evaluate the experts. One of the well-proven in the management of mathematical methods of work with high-quality information is proposed 40 years ago, the theory of fuzzy sets. Today, this theory is fashionable and effective mathematical tool to work in conditions of uncertainty.

To build the model of decision making we will use the method of fuzzy multi-criteria analysis of options to take into account peculiarities of creation of intelligent information systems. The method is based on the following principles:

1) criteria are considered as fuzzy sets, defined the universal set of alternatives with the help of the membership function;

2) membership functions of fuzzy sets are defined according to expert pairwise comparisons of alternatives;

3) the coefficients of importance of criteria concentrate the corresponding fuzzy sets;

4) the decision is made by the scheme Bellman-Zadeh by the intersection of fuzzy sets of criteria, which corresponds to choosing the type who best meets all criteria simultaneously.

Fuzzy multi-criteria model analysis of alternatives.

Denoted as $\mu_{G_i}(P_j)$ number from the interval [0, 1], which project $P_j \in P$ is evaluated according to criteria $G_i \in G$: the greater the number $\mu_{G_i}(P_j)$, the better the project P_j criterion G_i, $j = \overline{1,k}$, $i = \overline{1,n}$. Then the criterion G_i can be represented by fuzzy set $\tilde{G}_i$ on the universal lot of information intelligent systems P:

$$\tilde{G}_l = \left\{ \frac{\mu_{Gi}(P_1)}{P_1}, \frac{\mu_{Gi}(P_2)}{P_2}, ..., \frac{\mu_{Gi}(P_k)}{P_k} \right\}, \quad (2)$$

where $\mu_{G_i}(P_j)$ – the degree of membership of element P_j fuzzy set $\tilde{G}_i$.

Find the degree of membership of a fuzzy set (2) will the method for construction of membership functions on the basis of pairwise comparisons. For each pair of projects expert criterion G_i ($i = \overline{1,n}$) evaluates the advantage of one option over another. Paired comparison it is convenient to specify this matrix:

$$A = \begin{array}{c} \\ P_l \\ P_2 \\ ... \\ P_k \end{array} \begin{array}{cccc} P_l & P_2 & ... & P_k \\ \left[\begin{array}{cccc} a_{11} & a_{12} & ... & a_{1k} \\ a_{21} & a_{22} & ... & a_{2k} \\ ... & & & \\ a_{k1} & a_{k2} & ... & a_{kk} \end{array} \right] \end{array},$$

where a_{ij} – the advantage of the project P_i before project P_j ($i, j = \overline{1,k}$), is determined by the whole scale Sahati:

1 – if the advantage is absent;
3 – if the advantage of the weak;
5 – if a significant advantage;
7 – if a distinct advantage;
9 – if the absolute advantage;
2, 4, 6, 8 – intermediate comparative evaluation.

Matrix of pairwise comparisons A is diagonal ($a_{ij} = 1$) and back symmetrical $a_{ij} = \dfrac{1}{a_{ij}}$, $i, j = \overline{1,k}$. The degree of fuzzy membership (2) correspond to the coordinates of the eigenvectors $W = (w_1, w_2, ... w_k)^T$ of the matrix A: $\mu_G(P_j) = w_j$, $j = \overline{1,k}$. Own vector is found using the following equations:

$$\begin{cases} A \times W = \lambda_{max} \times W \\ w_1 + w_2 + ... + w_k = 1 \end{cases}, \quad (3)$$

where λ_{max} is the largest eigenvalue of the matrix A.

According to the principle of Bellman-Zadeh, will be the best alternative that to the greatest extent simultaneously satisfies all the criteria. Fuzzy solution is the intersection of individual criteria:

$$\tilde{D} = \tilde{G}_1^{\alpha 1} \bigcap \tilde{G}_2^{\alpha 2} \bigcap ... \bigcap \tilde{G}_n^{\alpha n} = \left\{ \frac{\underset{i=1,n}{\min}\left(\mu_{Gi}^{\alpha i}(P_1)\right)}{P_1}, \frac{\underset{i=1,n}{\min}\left(\mu_{Gi}^{\alpha i}(P_2)\right)}{P_2}, ..., \frac{\underset{i=1,n}{\min}\left(\mu_{Gi}^{\alpha i}(P_k)\right)}{P_k} \right\}, \quad (4)$$

where α_i is the coefficient of relative importance of criteria G_i, $\alpha_1 + \alpha_2 + ... \alpha_n = 1$. The exponent α_i in the formula (4) concentrates the membership function of a fuzzy set in $\tilde{G}_i$ accordance with the importance of the criterion G_i. The coefficients of relative importance of criteria can be defined in various ways - for example, using the method of pairwise comparisons Saaty. According to fuzzy solution to (4) will be the best project

with the maximum degree accessories:

$$D = \arg\max\left(\mu_D(P_1), \mu_D(P_2), ..., \mu_D(P_k)\right). \quad (5)$$

In the work we compared four project on the development of intelligent information systems on the six criteria according to a fuzzy model of multicriterial analysis of alternatives given above.

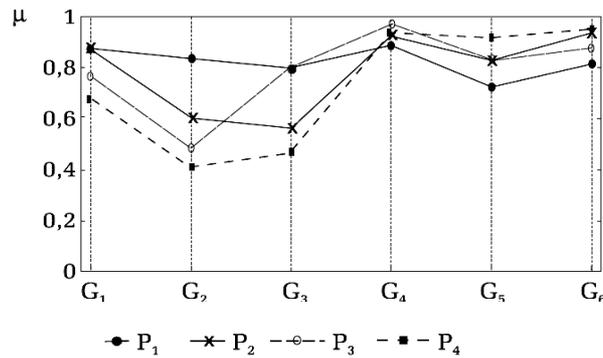When comparing projects was received this result: fig. 1.

Fig. 1. Comparing projects against the criteria

Thus, the project P_1, better than others simultaneously satisfies all of the criteria according to their importance. The paper presents the rules that allow to investigate the sensitivity of the solution to variations of the initial pairwise comparisons of alternatives.

Using these rules, you can identify ways to improve the efficiency of the IIS, which will ensure its dominance over the other options.

Conclusions

Implementation of IT- projects without analysis of alternatives leads to an increase in its value, increases the level of potential risks, and the effect is far from expected. Errors in risk assessment can lead to incorrect management decisions, it is important to promptly identify and evaluate all project risks.

In this diploma project achieved the goal: the development of is increasing the quality of decisions on the selection of it projects (in terms of inaccurate and uncertain expert information based on the use of fuzzy linguistic variables) and allows you to make appropriate and informed decisions using subjective quality expert information provided, including, in the form of interval estimates.

To achieve it have been resolved the next tasks:

– The features of evaluation projects IT-projects.

– The selection and assessment criteria assessment of the risk of IT-projects.

– The selection and sorting of risk IT-projects.

– The appropriateness of the method of fuzzy multi-criteria analysis when selecting the best IT-project.

Using these rules it is possible to identify ways of improving the efficiency of IT-projects that will ensure its dominance over the other options.

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ПІДВИЩЕННЯ ЕФЕКТИВНОСТІ ІТ-ПРОЕКТІВ ЗА РАХУНОК МІНІМІЗАЦІЇ РИЗИКІВ ЗА ДОПОМОГОЮ МЕТОДІВ НЕЧІТКОЇ ЛОГІКИ

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У статті розглядаються проблеми керування ризиками в розробці та реалізації ІТ-проектів на основі нечіткої логіки. Розглянути приклади внутрішніх проектних ризиків і можливі шляхи їх зменшення. В якості критерію вибору найбільш ефективного проекту пропонується дев'ятибальна шкала Сааті та «метод найгіршого випадку», основу яко-го складає принцип перетинання нечітких критеріїв Белмана-Заде.

Ключові слова: *управління ризиками ІТ-проектів, нечіткі множини, нечітка логіка, нечітка змінна, лінгвістична змінна, ІТ - проект, стандарти управління ІТ - проектами.*

ПОВЫШЕНИЕ ЭФФЕКТИВНОСТИ ИТ-ПРОЕКТОВ ЗА СЧЕТ МИНИМИЗАЦИИ РИСКОВ С ИСПОЛЬЗОВАНИЕМ МЕТОДОВ НЕЧЕТКОЙ ЛОГИКИ

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В статье рассматриваются проблемы управления рисками в разработке и реализации ИТ-проектов на основе не-четкой логики. Рассмотрены примеры внутренних проектных рисков и возможные пути их уменьшения. В качестве критерия выбора наиболее эффективного проекта предлагается девятибалльная шкала Саати и «метод наихудшего случая», основу которого составляет принцип пересечения нечетких критериев Беллмана-Заде.

Ключевые слова: *управление рисками ИТ-проектов, нечеткие множества, нечеткая логика, нечеткая переменная, лингвистическая переменная, ИТ-проект, стандарты управления ИТ-проектами.*