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MODELS FOR THE FORMATION OF IT COMPANY STRATEGIC PORTFOLIO OF PROJECTS

Increasing of unpredictability, novelty and complexity of the external environment of modern enterprises of IT industry has led to the need of creating such management mechanisms that can ensure making of coordinated and effective decisions to adapt enterprises to the external competitive environment, ensure their survival and successful development. In order to adapt to rapidly changing environmental conditions it is necessary to apply management that is associated not so much with the definition of a strategic position (long-term and strategic planning), as with a timely, real-time response to rapid and unexpected changes. Formation of adequate management forces enterprises to engage in the refinement of the strategy and the solution of the arisen strategic tasks simultaneously and in parallel, to apply scientifically based management information technologies. Creation of such technologies requires the availability of adequate models of production activities of IT company. A set of interrelated models of forming a strategic portfolio of IT projects of a company, whose activity is aimed at creating a finite number of IT projects in the context of time and resource constraints, is proposed. A set of interrelated models for the formation of IT projects strategic portfolio activity of which is aimed at creating a finite number of unique software products in conditions of time and resource constraints is proposed. Qualitative and quantitative methods of modeling of IT company production activity were used while developing a set of models and generated a set of models of expert procedure and a set of models of optimization procedure. The set of expert procedure models for assessing of IT projects significance realizes the hierarchies analysis method. The set of models of optimization procedure implements the method of linear programming which allows to determine the effective structure of the IT projects portfolio in the medium term which ensures achievement of company strategic goals. Based on the developed set of models, a generalized algorithmic model for the formation of company strategic portfolio of projects is formed and can be used to create information technology for strategic planning of IT company production activities in conditions of dynamic external environment.

Keywords: set of models, optimization procedure, expert procedure, portfolio of projects, enterprise, information technology.

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МОДЕЛІ ФОРМУВАННЯ СТРАТЕГІЧНОГО ПОРТФЕЛЯ ПРОЕКТІВ ІТ ФІРМИ

Підвищення непередбачуваності, новизни і складності зовнішнього середовища сучасних підприємств ІТ індустрії призвели до необхідності створення таких механізмів управління, які були б здатні забезпечити прийняття скоординованих і ефективних рішень по адаптації підприємств до зовнішнього конкурентного середовища і забезпечення їх виживання і успішного розвитку. Для адаптації до швидко змінюючихся умов середовища потрібне застосування управління, пов'язаного не стільки з визначенням стратегічної позиції (довгострокове і стратегічне планування), скільки зі своєчасною реакцією в реальному масштабі часу на швидкі і несподівані зміни. Формування адекватного управління змушує підприємства одночасно паралельно займатися уточненням стратегії і рішенням виниклих стратегічних задач, застосовувати науково обгрунтовані інформаційні технології управління. Створення таких технологій вимагає наявності адекватних моделей виробничої діяльності ІТ фірми. Пропонується комплекс взаємопов'язаних моделей формування стратегічного портфеля проектів ІТ фірми, діяльність якої спрямована на створення кінцевого числа ІТ проектів в умовах часових та ресурсних обмежень. При створенні комплексу моделей використані якісні і кількісні методи моделювання виробничої діяльності ІТ підприємства, що породили комплекс моделей експертної процедури і комплекс моделей оптимізаційної процедури. Експертна процедура забезпечує оцінку значущості ІТ проектів з використанням методу аналізу ієрархій. Комплекс моделей оптимізаційної процедури реалізує метод лінійного програмування, що дозволяє в середньостроковій перспективі визначити ефективну структуру стратегічного портфеля ІТ проектів, що забезпечує досягнення стратегічних цілей ІТ фірми. На основі побудованого комплексу моделей розроблено узагальнену алгоритмічну модель формування стратегічного портфеля ІТ проектів, яка може бути використана при створенні інформаційної технології стратегічного планування виробничої діяльності ІТ підприємства в умовах динамічного зовнішнього середовища.

Ключові слова: комплекс моделей, оптимізаційна процедура, експертна процедура, портфель ІТ проектів, підприємство, інформаційна технологія.

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МОДЕЛИ ФОРМИРОВАНИЯ СТРАТЕГИЧЕСКОГО ПОРТФЕЛЯ ПРОЕКТОВ ИТ ФИРМЫ

Повышение непредсказуемости, новизны и сложности внешнего окружения современных предприятий ИТ индустрии привели к необходимости создания таких механизмов управления, которые способны обеспечить принятие скоординированных и эффективных решений по адаптации предприятий к внешней конкурентной среде и обеспечению их выживания и успешного развития. Для адаптации к быстро меняющимся условиям среды требуется применение управления, связанного не столько с определением стратегической позиции (долгосрочное и стратегическое планирование), сколько со своевременной реакцией в реальном масштабе времени на быстрые и неожиданные изменения. Формирование адекватного управления вынуждает предприятия одновременно параллельно заниматься уточнением стратегии и решением возникших стратегических задач, применять научно обоснованные информационные технологии управления. Создание таких технологий требует наличия адекватных моделей производственной деятельности ИТ фирмы. Предлагается комплекс взаимосвязанных моделей формирования стратегического портфеля проектов ИТ фирмы, деятельность которой направлена на создание конечного числа ИТ проектов в условиях временных и ресурсных ограничений. При создании комплекса моделей использованы качественные и количественные методы моделирования производственной деятельности ИТ предприятия, породившие комплекс моделей экспертной процедуры и комплекс моделей оптимизационной процедуры. Экспертная процедура обеспечивает оценку значимости ИТ проектов с использованием метода анализа иерархий. Комплекс моделей оптимизационной процедуры реализует метод линейного программирования, позволяющий в среднесрочной перспективе определить эффективную структуру стратегического портфеля ИТ проектов, обеспечивающего достижение стратегических целей ИТ фирмы. На основе построенного комплекса моделей разработана обобщенная алгоритмическая модель формирования стратегического портфеля ИТ проектов, которая может быть использована при создании информационной технологии стратегического планирования производственной деятельности ИТ предприятия в условиях динамической внешней среды.

Ключевые слова: комплекс моделей, оптимизационная процедура, экспертная процедура, портфель ИТ проектов, предприятие, информационная технология.

Introduction. Modern stage of Ukrainian economy external environment, increasing competition in domestic development is characterized by high dynamics of an and foreign markets, development of information

technologies tools and information technologies. All this actualizes strategic aspects of enterprise production activity management in the IT sector and requires a conscious selection of common development directions to achieve long-term corporate goals considering existing restrictions dictated by both the external and internal environment of the IT company. Depending on the level of instability of the external environment, there are four classes of enterprise management methods [1, 2, 3]: management methods based on execution control [3, 4]; extrapolation-based control methods [3, 4]; management methods based on the prediction of change (the future is partly predictable) [5, 6, 7]; management methods based on flexible urgent solutions (the future is unpredictable) [1, 3, 8, 9], which are the methods of strategic management that provide management of strategic capabilities of enterprise [3, 4, 5, 9]. Strategy formed by these methods determines the direction of development of the enterprise towards its target state while leaving the freedom of choice taking into account the changing situation in the external environment, current restrictions dictated by both the internal and external environment of the enterprise. Application of strategic management methods to formation of the portfolio of IT projects will allow to link portfolio projects with the achievement of the strategic goals of the IT company, provided that the limited resources for projects are effectively allocated [3, 10].

Therefore, the purpose of the work is to increase the profitability of the IT company by creating a set of models for the formation of a strategic portfolio of projects that ensures effective achievement of company strategic goals taking into account existing resource constraints.

Formulation of the problem. Achieving the competitive advantage of IT company is not only a consequence of the successful implementation of its portfolio of projects, but also the correct selection of morphology and projects portfolio structure that determine vector of IT company strategic development in a competitive external environment. Due to that, there arises the task to form an effective portfolio of IT company projects with an incremental style of behavior that can

create a finite set $\Pi = \overline{IT\Pi_S}, S = \overline{1, n}$ of IT projects (ITP). Further, ITP is understood as an activity of creating a unique software product in terms of time and resource constraints. It is assumed that for implementation of $IT\Pi \in \Pi$ at a given time interval the company has limited resources (labor, information, energy, natural, basic and circulating funds, etc.). All the necessary qualitative and quantitative information about past and current state of the IT company, its internal and external environment, and the results of its production activities is known. The task is to create a set of models that form such portfolio of IT company projects from $IT\Pi \in \Pi$ that at a given medium-term time interval, in conditions of available limited resources provides maximum allowable amount of profit with minimal risks for the company.

Set of models. A qualitative analysis of accumulated empirical evidence, generalization of IT company functioning experience are the source for determining promising directions of its strategic development. Therefore when developing a set of models for the formation of an effective portfolio of IT company projects (EPP) it is proposed to use qualitative and quantitative methods of modeling. Fig. 1 illustrates general scheme of formation of EPP, that contains an expert procedure designed to determine effective structure of the IT company projects portfolio.

As a theoretical basis for the expert procedure, it is proposed to use the hierarchy analysis method [11] which presumes decomposition of the problem of defining the project portfolio morphology into increasingly simpler components interaction of which is determined by the hierarchical model of impact of $IT\Pi \in \Pi$ on the increase of the IT company profit. At the first level of the hierarchy there is one vertex that determines focus of the problem (increase of profit).

The second level is determined by main objectives of the IT company: profit increase; cost reduction; risk reduction. The third level is determined by ITP groups which set directions of the IT company production activity. The lower level of the hierarchy is formed by $IT\Pi_S \in \Pi$.

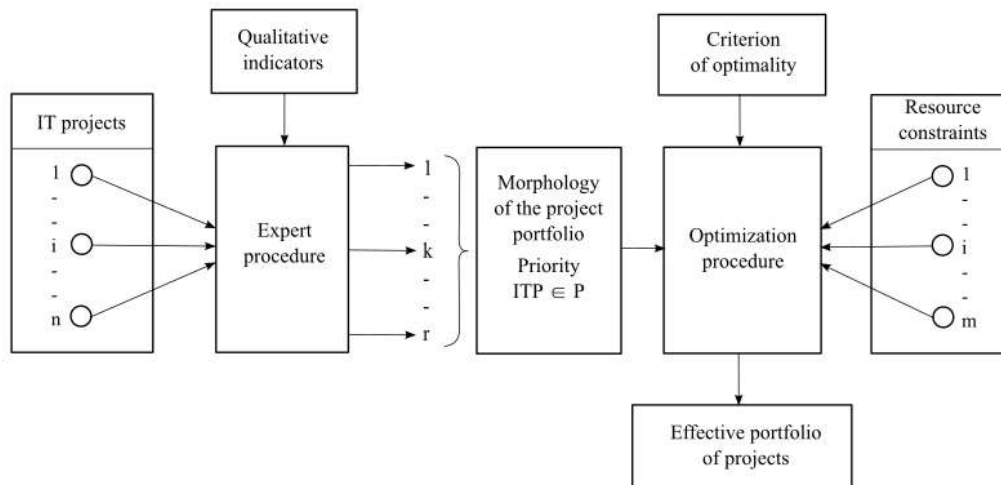


Fig. 1. General scheme for the formation of an effective portfolio of company IT projects

Based on the hierarchy for each of its maternal vertices an estimation of weight coefficients, that determine degree of its dependence on the vertices of the lower level that affect it, is given. For the formation of estimation a group that contains r experts from among IT company leading specialists is formed. Each expert with a number s , $s = \overline{1, r}$, forms a matrix of paired comparisons $A^s = (a_{ij}^s)$. The elements a_{ij} of the generalized matrix $A = (a_{ij})$ of pairwise congruencies are determined by the expression $a_{ij} = (\prod_{s=1}^r a_{ij}^s)^{\frac{1}{r}}$. The normalized eigenvector that corresponds to majorizing matrix root A determines local priorities of lower-level elements. Based on the local priorities of the hierarchy vertices and by using the hierarchical synthesis procedure of global priorities w_j , $w_j \geq 0$, $\sum_{j=1}^n w_j = 1$, of IT projects that make up composition of Π are found. The composition of $IT\Pi_s \in \Pi$ that determine the morphology of EPP are found by ranking $IT\Pi_j$ according to degree of decrease of their global priorities w_j and selection of the first $IT\Pi_{s_i}$ in Π_0 set in the resulting row, the sum of global priorities w_{s_i} is equal to $\alpha = 0,8 \pm \varepsilon$, ε – is admissible error.

Priorities w_i

$$IT\Pi_i \in \Pi_0 = \{IT\Pi_{s_i} : \sum_{i=1}^p w_{s_i} = 0,8 \pm \varepsilon\}, \quad (1)$$

where p – power of Π_0 , are found by rationing $w_i = w_{s_i}/\alpha$. Herewith $w_i \geq 0$, $\sum_{i=1}^p w_i = 1$.

A set $M_1 = \{M_{1i}\}$ of models M_{1i} that provide the expert procedure contains:

M_{11} – algorithmic model of the hierarchical model formation;

M_{12} – algorithmic model of the formation for all of hierarchy maternal vertices of pairwise matrices A^s and generalized matrices A ;

M_{13} – algorithmic model for determining the local priorities of the vertices for the second, third and fourth hierarchy levels;

M_{14} – algorithmic model for determining global priorities $IT\Pi_s \in \Pi$;

M_{15} – algorithmic model for the formation of a set Π_0 of ITP projects that define the morphology of the EPP.

As a theoretical basis for creating the optimization procedure it is proposed to use linear programming method that allows in the medium-term perspective to define volumes of production of $IT\Pi_s \in \Pi_0$ that ensures achievement of IT company strategic objectives.

A general approach to solving the problem of volumetric planning assumes that the IT company is aware of the following information:

j – the project nomenclature number from Π_0 , $j = \overline{1, n}$;

n – power of Π_0 ;

b_i – volumes of limited resources (labor resources of various professional groups, fund for operating time of equipment for various purposes, raw materials and consumables, energy carriers, information resources, salary fund, etc.), $i = \overline{1, m}$;

standards for expenditure of resources for implementation and realization of the project;

profitability of $IT\Pi_j \in \Pi_0$;

requirement for the volume of projects realization.

Since the focus of the problem in determining the morphology of the EPP was to increase the profit of the IT so company linear form of the linear programming is the following:

$$L = \sum_{j=1}^n c_j w_j x_j \rightarrow \max, \quad (2)$$

where L – profit from the realization of projects;

c_j – profitability of project;

w_j – expected amount of risk determined by the probability that completed project will be paid by customer;

x_j – number of projects of j -th nomenclature.

Maximization of revenue (2) is carried out when the restrictions are met.

Limitations of project implementation volume

$$\sum_{j=1}^n s_j x_j \geq w, \quad (3)$$

where w – requirements for project implementation volume in the planned period.

Restriction on resources

$$\sum_{j=1}^m b_{ij} x_j \leq b_j, i = \overline{1, m}, \quad (4)$$

where b_{ij} – norm of the expenditure of i -th resource for one project of j -th nomenclature.

Restrictions on production volumes of j -th nomenclature projects

$$\alpha_j \leq x_j \leq \beta_j, j = \overline{1, n}, \quad (5)$$

where value α_j is determined by the existing contractual obligations of IT company;

β_j – projects market opportunities of j -th nomenclature.

The mixed form of writing a linear programming objective makes it very difficult to assign an initial support plan when solving it by a finite method. Therefore, it is proposed to determine its solution by the M-method.

A set $M_2 = \{M_{2i}\}$ of models M_{2i} that provide the optimization procedure contains [12]:

M_{21} – algorithmic model of initial simplex tables formation that are required by M-method;

M_{22} – algorithmic model for determining solution of the objective (1-4);

M_{23} – algorithmic model for verifying reliability of the obtained solutions;

M_{24} – algorithmic model of conducting numerical experiments;

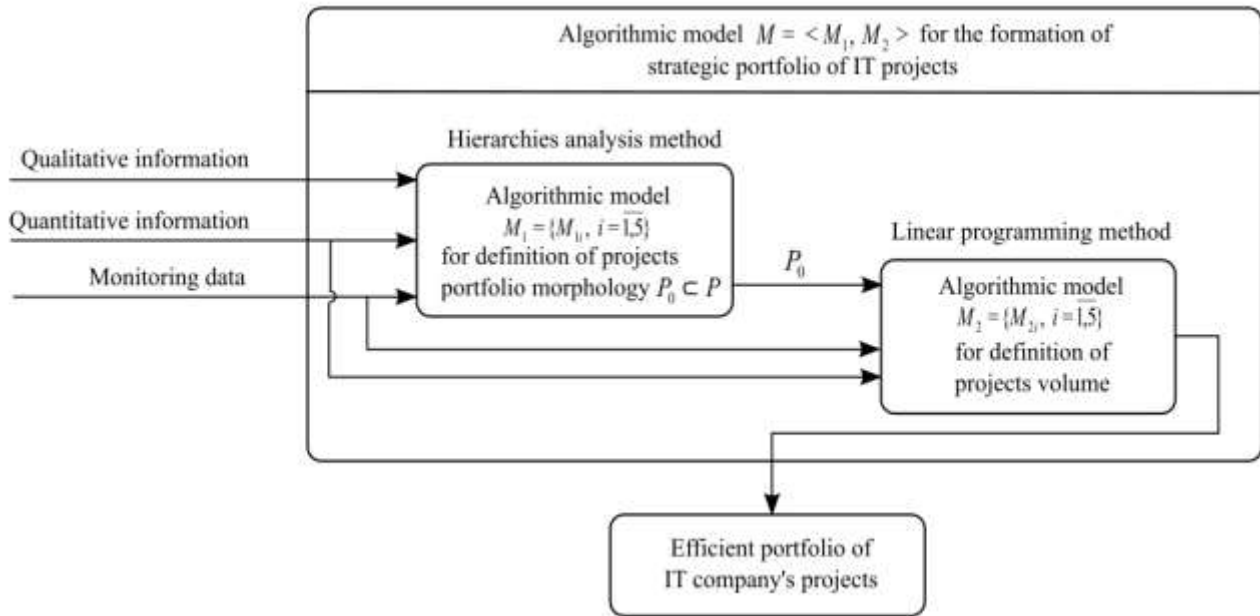


Fig. 2. Generalized structure of the algorithmic model for the formation of the IT company strategic portfolio of projects

M_{25} – algorithmic model for studying stability boundaries of the obtained volumetric optimal plan for implementation and realization of projects from Π_0 .

Fig. 2 illustrates a generalized structure of algorithmic model $M = \langle M_1 | M_2 \rangle$ for the formation of the strategic portfolio of projects.

Constructed algorithmic model prevents the possibility of many errors at a design stage of the program.

The constructed set of models $M = \{M_{1i}, M_{2i}, i = \overline{1,5}\}$ provides a clear formulation, purpose, content of individual parts of the program, allows paying considerable attention to ensuring the simplicity of software implementation structure of the algorithmic model, to significantly reduce costs, time expenditures for developing the software solution for the task of forming of the efficient portfolio of IT company projects, that operates in a competitive environment of IT industry.

Conclusions. The set of models of the expert procedure for determining the significance of IT projects was developed. The set of models of the optimization procedure for determining the effective structure of IT projects which determines the company strategic goals was elaborated as well. Besides, the algorithmic model for the formation of the company strategic portfolio of projects was worked out which can be used to create information technology for strategic planning of the company production activities.

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