The Method of Forming a Dynamic Projects Portfolio of IT Companies

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Abstract. The formation of the IT company project portfolio considered within the confines of strategic development planning. It is proposed that the formation of the portfolio be carried out based on the criterion of maximizing the utility function. The utility function is formed as an additive convolution of the utility functions of the efficiency criteria, risk and benefit from the implementation of this project for the company's development. It is suggested to consider the totality of IT company project portfolios by years of the planned strategic period as a dynamic object. The process of forming a dynamic project portfolio has two stages: at the first stage, the strategic task of forming a dynamic portfolio is solved as a set of portfolios by years of the planning period; at the second stage, this portfolio is managed. Management involves changing the composition of the portfolio according to the changing policies by the years of the planning period. Company policies during the planning period are adjusted depending on changes in the situation in the IT market. Some results of the implementation of the dynamic portfolio formation method for Ukrainian IT-company are presented. The implementation of this method allowed the project office to rationally plan the company resources, determine activity directions in the IT market, and adjust the development policy of the company on the strategic period.

Keywords: Dynamic Project Portfolio, Company Development, Company Policy, Utility Function.

1 The problem of creating a project portfolio of IT companies

Each IT company in the development of projects faces many challenges. The problems of managing a portfolio of projects [1] remain relevant. Portfolio management strategies are being formed, on the basis of which project implementation plans are determined [2, 3]. Most often, the project portfolio is formed taking into account the current situation of the IT market for short periods. Because IT companies operate in an increasingly competitive environment, there is a problem of the formation of the portfolio on a strategic period [4]. A lot of IT companies usually form a project port-

folio based on the criterion of maximizing profits [5, 6]. However, this approach does not allow adding to the portfolio projects with less profit, but with greater benefit for the company's development. For example, if the project implementation can bring small profit or zero profit for the IT Company, but the customer of this project may have profitable projects in the future [4].

Therefore, when forming project portfolios as part of strategic planning, it is important to consider projects that will not only be profitable for the company, but also be of strategic importance. The set of IT company project portfolios by years of the planned strategic period will be called the dynamic portfolio of IT projects. A dynamic object is a physical object, phenomenon or technological process that is subjected to external influences and as a result changes its state, behavior. The state of a dynamic object is evaluated by some parameters, and its behavior is characterized by a change in these parameter values over time. A distinctive feature of a dynamic object is that it has inertia and (or) interactions between its elements extend to a finite period. Then, by analogy, the totality of IT company portfolios, which are formed by years of the planning period, can be considered as a dynamic object. A change in its composition over time leads to a change in its main indicators – profitability and risk. The situation on the IT market and the economic situation in the country will be considered as an external impact on the portfolio structure and its indicators. The project portfolio is formed taking into account the strategic development goals of the IT company and the strategy for their achievement in the planning period. When setting goals and strategies the influence of external influences on the company's activities and forecasts about the IT market situation is taken into account.

The process of forming a dynamic project portfolio is proposed to be carried out in two stages: at the first stage, the strategic task of forming a dynamic portfolio as a set of portfolios by year period is solved; at the second stage, this portfolio is managed. Management means changing the portfolio composition according to changing policies by the years of the planning period. Policies are adjusted depending on changes in the IT market situation.

2 Stage 1. The Strategic Level of Formation for a Dynamic Portfolio.

2.1 IT Company Policy Approval

The IT company policy is developed based on strategic development goals and the results of the forecasted situation analysis in the IT market by years of the strategic period. Type of policy $I\hat{P}^t = \{\hat{P}^t, \hat{R}^t\}$, $t = 1,T$ will determine the minimum value of project profitability $\hat{P}^t$ and the maximum risk level of the project $\hat{R}^t$ [6].

2.2 The Formation of IT Projects - Applicants for Inclusion in the Portfolio by Year of the Planning Period

The indicators of the effectiveness and risk of projects – applicants for inclusion in portfolios are calculated. Each project b_j^t, $j \in \breve{J}^P$ is characterized by the tuple $< S_j^{bt}, \xi_j^{bt} >$; S_j^{bt} – the project cost; ξ_j^{bt} – the value of the utility function of the project,

$$\xi_j^{bt} = \sum_{i=1}^{N^p} \rho_i^p \xi_{ij}^t ;$$

N^p – the number of local criteria for evaluating the project (for example, profitability, risk, significance or benefits for the development of an IT company, etc.); ρ_i^p – weighting coefficient, its value is determined by the expert depending on the adopted policy of the IT company [7]; ξ_{ij}^t – normalized value of the utility function for the criterion K_i;

$$\xi_{ij}^t = (K_i(b_j^t) - K_i^{worst}) \Big/ K_i^{best} - K_i^{worst},$$

$K_i(b_j^t)$ – the current value of the criterion K_i for the project b_j^t;

K_i^{worst}, K_i^{best} – respectively, the best and worst value in the allowable range of its values.

The benefit of IT project implementing for the company's development is determined by experts based on prospects analysis of working with the customer of this project throughout the entire strategic period.

The project b_j^t, $j \in \breve{J}^P$ is included in set $\bar{B}^t$ if its utility function value (ξ_j^{bt}) is in the valid range,

$$\xi_{\min}^t \le \xi_j^{bt} \le \xi_{\max}^t ;$$

$\xi_{\min}^t$, $\xi_{\max}^t$ – accordingly, the minimum and maximum acceptable utility function value. As a result, project sets $\bar{B}^t = \{\bar{b}_j^t\}$, $j \in Q^t$ by year of the planning period are being formed. These sets are considered as the first portfolio options.

The project office of the IT company analyzes the projects $\bar{B}^t = \{\bar{b}_j^t\}$, $t = \overline{1,T}$, determines their compliance with company policy $I\hat{P}^t = \{\hat{P}^t, \hat{R}^t\}$ and the possibilities of providing the project with certain resources.

2.3 Determining the Project Implementation Impact on Company Development

A procedure to determine the indicator of the impact of IT project development on the strategic development of the company is proposed to use which is based on expert methods and factor analysis.

It is assumed that the IT Company has strategic goals and strategies for achieving them. Implementation of IT projects enables the company carrying out these strategies. When considering each project, it is necessary to determine not only its profit and risk but also the degree of its influence on the company development. Experts are involved as specialists in the field of IT company development management.

They determine the factors of the project's influence on the strategic IT company development, taking into account the activities of the company, development goals and strategies. Factors are divided into 2 groups:

1. factors that are directly related to the project, for example, the novelty of the project for the company or the compliance level of the project with the company's IT profile; terms of its implementation (short-term, medium-term or long-term); the involvement extent of IT company employees in the project, the possibility of staff training during project development, etc.
2. factors that are associated with the project customer, for example: the relations history with the customer (whether the customer is a regular); the relations prospects between the IT company and the customer (will the cooperation be continued in other projects?); customer's business environment (his connections in the business; customer competitiveness in the branch of economics; financial condition of the project customer; customer relationship with the software product life cycle (within the vertical integration of the company and the customer), etc.

Hierarchy of three levels is built based on hierarchy analysis method (see Fig. 1).

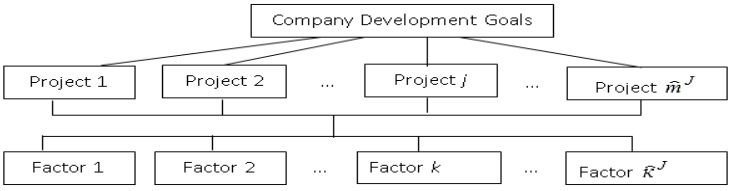

Fig. 1. Hierarchy for determining the impact of project implementation on company development

Experts evaluate the project impact on development for each factor. The results are processed based on the expert method of pairwise comparisons [8]. As a result, a pairwise comparisons matrix for projects is built. The implementation impact of the IT project on the company development is defined as an aggregate indicator:

$$\hat{C}_j = \sum_{k \in \hat{K}^J} \alpha_j^k c_j^k, \; j \in \hat{J},$$

c_j^k – the extent of influence of the IT project on the development of the company by factor *k*; $\widehat{K}^J$ – a set of factors, $\widehat{\kappa}^J = |\widehat{K}^J|$, $\widehat{\kappa}^J$ – the number of factors influencing the IT project on the company development; $\widehat{m}^J = |\widehat{J}|$, $\widehat{m}^J$ – the number of IT projects; α_j^k – priority of the influence factor *k*, which is established on the basis of expert assessments.

Thus, the impact indicator $\widehat{C}_j$ of the IT project implementation on the company development will be considered as a criterion for the projects selection for inclusion in the portfolio of IT company projects.

3 Stage 2. The Tactical Level of Formation for a Dynamic Portfolio

3.1 The Projects Selection for the Formation of the Portfolio.

The project office forms project sets, so

$$\breve{C}^t = \overline{B}^t \bigcup A^{t-1},$$

A^{t-1} – the project set, the implementation of which, in agreement with customers, has been moved from the interval (*t*–1) to the interval *t*, $A^0 = \varnothing$.

3.2 Iterative Procedure for Project Portfolios Forming

At each iteration *l*, on the set of candidate projects ${}^l\breve{C}^t$ (for $l = 1$ ${}^1\breve{C}^t = \breve{C}^t$) the portfolio ${}^l\breve{B}_p^t$ is formed. To do this, solve the following problem:

$$D^t = \sum_{j \in {}^l\breve{Q}_C^t} {}^l\xi_j^{bt} \cdot x_j^t \xrightarrow[\{x_j^t\}]{} \max \tag{1}$$

$$\sum_{j \in \breve{Q}_C^t} {}^l s_j^{bt} \cdot x_j^t \Big/ \sum_{j \in \breve{Q}_C^t} \widehat{S}_j^{bt} \cdot x_j^t \geq \widehat{P}^t, \tag{2}$$

$$x_j^t \in \{0,1\}, \tag{3}$$

$j \in {}^l\breve{Q}_C^t$;

${}^l s_j^{bt}$ – The cost of the project from the set ${}^l\breve{C}^t$;

${}^l\xi_j^{bt}$ – The value of the utility function for the project from the set ${}^l\breve{C}^t$;

$\widehat{S}_j^{bt}$ – The planned costs of the IT company for the project implementation b_j^t, $j \in {}^l\breve{Q}_C^t$.

Project office analyzes portfolio projects ${}^{l}\breve{B}_P^t$ and projects that are not included in it ${}^{l}\widetilde{C}^t = {}^{l}\breve{C}^t \setminus {}^{l}\breve{B}_P^t$. The office offers project customers from the set ${}^{l}\widetilde{C}^t$ a variety to change the project conditions (for example, cost, terms of the project, etc.). After the approval procedure, the set of projects ${}^{l+1}\breve{C}^t = {}^{l}\breve{C}^t \setminus {}^{l}\overline{A}^t \setminus {}^{l}A^t$ (that are candidates for inclusion in the portfolio at the iteration (l + 1)), are formed; ${}^{l}A^t$ – the set of projects whose customers agreed implementing them at the interval (t + 1) at the iteration l; ${}^{l}\overline{A}^t$ – the set of projects whose customers refused implementing them in the planning period. Projects from the set ${}^{l}\widetilde{\breve{C}}^t = {}^{l}\widetilde{C}^t \setminus {}^{l}\overline{A}^t \setminus {}^{l}A^t$, ${}^{l}\widetilde{\breve{C}}^t \subseteq {}^{l+1}\breve{C}^t$ for which the conditions of implementation have been changed are included in the set ${}^{l+1}\breve{C}^t$.

For the set of projects, ${}^{l+1}\breve{C}^t$ problem (1)–(3) is solved. The iterative procedure ends if there are no projects with modified conditions ${}^{l}\widetilde{\breve{C}}^t = \varnothing$. Thus, as a result of the iterative procedure, such sets (see**Помилка! Джерело посилання не знайдено.**):

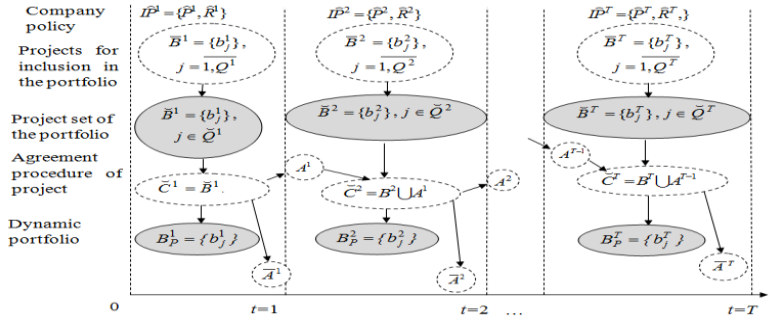

Fig. 2. Formation of the dynamic project portfolio for IT Company

– Project portfolios $B_P^t = {}^{l}\breve{B}_P^t$ which will be implemented in the planning period according the company policy $I\widehat{P}^t = \{\widehat{P}^t, \widehat{R}^t\}$, $t = \overline{1,T}$. These portfolios will make up the dynamic IT company portfolio

$$B_P = \bigcup_{t=1}^{T} B_P^t \cdot$$

– The set of projects whose customers agreed to postpone the implementing of their projects to other years of the planning period

$$A = \bigcup_{t=1}^{T} A^t; \quad A^t = \bigcup_{l=1,2...} {}^{l}A^t \cdot$$

– The project set whose customers refused implementing projects in the period

$$\overline{A} = \bigcup_{t=1}^{T} \overline{A}^t; \quad \overline{A}^t = \bigcup_{l=1,2...} {}^{l}\overline{A}^t \cdot$$

The project office analyzes the income that the company will receive from implementation of the portfolios at each interval of the planning strategic period:

$$\overline{\overline{S}}^{It} = \sum_{j \in Q_P^t} s_j^{ct},$$

s_j^{ct} – Project cost $b_j^t \in B_P^t$, $j \in Q_P^t$.

The implementation of this method allowed the project office to analyze the company capabilities, the prospects of its activities, rationally plan the company resources, determine activity directions in the IT market, and adjust the development policies of the company by year of the strategic period.

The business process of forming an investment portfolio is proposed to be presented in the form of the following basic procedures [9] (see**Помилка! Джерело посилання не знайдено.**).

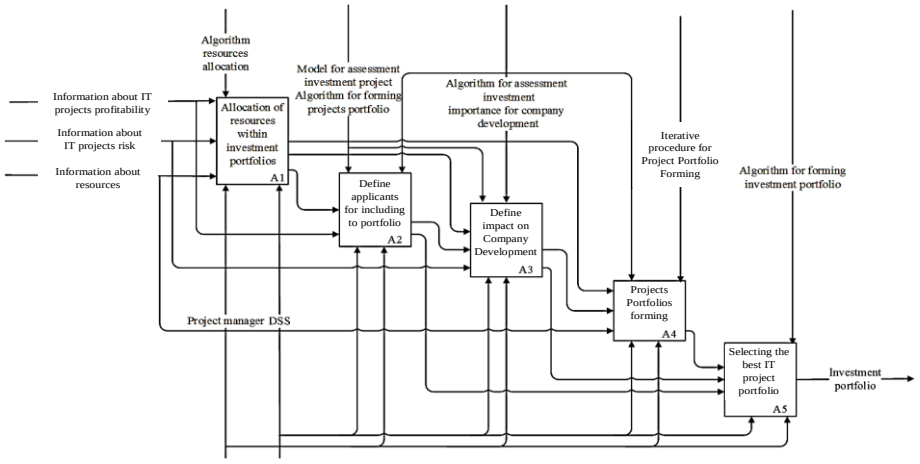

Fig. 3. Business process for the formation of IT project portfolio

4 Some Implementation Results of the Dynamic Portfolio Formation Method

The dynamic portfolio formation method was implemented in the practice of Ukrainian IT companies. The following types of IT projects are distinguished.

Software development projects is the activity that produces new products but it is not only expensive but also risky, for it is difficult to know beforehand what will work or what will sell. Even if a product is successful, then its essential features will eventually diffuse throughout the industry, or other firms will copy the product or the process to become more competitive. Nonetheless, in spite of diffusion, research and development does have its advantages. A firm that first develops a product or process can protect it legally by obtaining patents on the new product or process, copyrights

on the original writing or other media developments, and trademarks. It also gains a significant amount of time over other firms to develop economies of scale and to market the new product.

Software extension projects are less risky because the investment of resources takes place in the development of the existing and supposedly successful system, but also less profitable, because the main income was received by the company that issued the base product. However, the development and maintenance of interest in an existing product allows the company to receive a stable, albeit not high, income.

Information system (IS) implementation projects are characterized by high initial costs associated with the acquisition or development of their own product [10]. Regardless of the specific model of action, choosing the right strategy is a decisive factor for success in implementing the system. Typically, the "Big Bang", "Step by Step", or "prototype implementation" strategies are applied. The "step by step" approach involves the introduction of individual modules, processes or departments with a time shift. Along with reducing risk and simplifying project management, this leads to an increase in the timing of its implementation. In contrast, when choosing the "Big Bang" strategy, existing software at the set point in time is completely replaced by the new system. This is associated with increased risk and necessitates intensive testing; on the other hand, interfaces to other systems are not needed, so the benefits of integration are immediately apparent. Another alternative is prototype implementation.

Infrastructure IT projects are aimed at creating a set of interconnected information systems and services that ensure the functioning and development of enterprise information communication tools. Infrastructure projects are long-term, in terms of both implementation terms and terms of return on investments made in them [11].

The proposed method was implemented for the company "Dolina", which has investment activities. Over the past years, the company has been investing in the IT industry. Dolina's interests mainly lays in the field of financing projects related to software development projects, as well as to projects for implementing developed information systems based on a "Step-by-Step" strategy.

A structural unit has been created that develops IT projects in the medical field. The company's IT project portfolio at the start of planning totaled 11 projects. Typically, the project portfolio was formed for 1 year (see table 1).

Table 1. Old Portfolio structure.

	Software development projects	Software extension projects	IS implementation projects	Infrastructure IT projects
Number of projects	9	0	2	0

In 2016, it was decided to develop a strategic program for the development of the company for 4 years. As part of this program, development plans for all structural units were developed. Using the suggested method, project portfolios were formed at intervals of the planning period (see table 2).

Table 2. New Portfolio structure.

	Software development projects	Software extension projects	IS implementation projects	Infrastructure IT projects
Number of projects	7	0	3	1

Due to the procedure for agreeing on the conditions for the implementation of projects by customers, the total revenue of the company was increased by 10% (see table 3), and the risk was reduced by 2.2%.

Due to the preliminary selection of projects based on the utility function and the portfolio approval procedure, the profitability of the dynamic portfolio was increased by 1.6%; reduced risks by 24.5% (see **Помилка! Джерело посилання не знайдено.**).

Table 3. Portfolios comparison.

t	Portfolio income, thousand $	
	Portfolio according to the old scheme	Portfolio formed by this method
1	337.5	351.75
2	372.5	331.5
3	543.25	490.95
4	222.5	427.5
in total	1475.75	1601.7

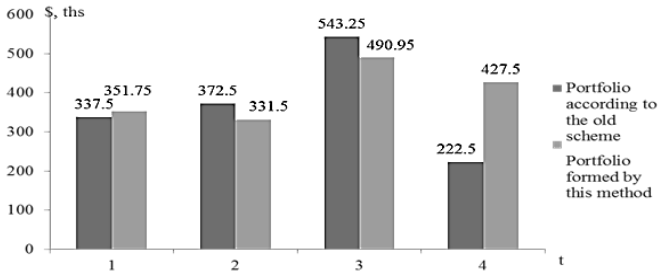

Fig. 4. Portfolio Income Dynamics.

Two projects related to the development of new products were excluded from the new portfolio, which reduced the company's risks. The released financial resources were allocated for the implementation of the infrastructure project, which, in combination with the project for the implementation of already developed software, made it possible to abandon interaction with third-party services and completely replaced the old system. A small decrease in profitability in the second and third years associated with the implementation of the infrastructure project was covered in the fourth year due to the launch of the infrastructure project in production.

5 Conclusion

The formation of the IT company project portfolio within the confines of strategic development planning is considered. The formation of the portfolio is carried out based on the criterion of maximizing the utility function taking into account the established company policy. Company policies during the planning period are adjusted depending on changes in the situation on the IT market. The dynamic portfolio formation method for some Ukrainian IT-companies was implemented. The implementation of this method allowed the project office to rationally plan the company resources, determine activity directions in the IT market, and adjust the development police of the company on the strategic period.

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