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Optimization Models of Rolling Planning for Project Portfolio in Organizations Taking Into Account Risk and Corporate Social Responsibility

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Abstract:

Modified multiperiod optimization models to support decision-making about the choice of the project portfolio under the program of strategic development of the organization are suggested. Corporate social responsibility of the organization is shown at setting goals, taking into account the interests of all stakeholders. Risks are accounted in the framework of portfolio investment theory of H. Markowitz using the scenario approach. The specific function of general utility, whose arguments are the levels to achieve the strategic objectives of the organization as a result of the project for the periods given the importance of the objectives and values of reduced costs for the project, is used as a target function. It is expected that the utility of the project will depend on how growth in levels to achieve the strategic objectives by periods occurs, while different growth rate of their level is preferred for different purposes. It is also expected that different structures of investing resources differ by preference for periods, due to which additional resource limitations for each time period are introduced in the model. The main difference between the proposed models is the ability to review the composition of the previously selected project portfolio at each step depending on the already achieved results and changes in internal and external conditions.

Keywords: program of strategic development of the organization, project portfolio, corporate social responsibility, utility function, scenario approach.

JEL Classification: O22, M15.

1. Introduction

The main instrument for implementing the strategy of any organization is an investment program consisting of a specific set of projects for the reconstruction and development (strategic measures), the result of which is to achieve (more or less) the strategic objectives of the organization. At the formation of the strategic development program within the constraints of available resources, a manager (decision maker, DM) is faced with the necessity of preliminary selection of projects. By choosing a certain set of projects, the DM in fact chooses a way to achieve the objectives.

Assessment of possible consequences (including social) and emerging risks must be no less important than resource constraints at the selection of projects. The approach taking into account the need for corporate social responsibility in the development of strategic plans (Maltseva 2009a), including the strategic cards of objectives (Maltseva 2009b, Solodukhin 2009), allows to consider the levels of achievement of the objectives achieved by the implementation of projects as utilities of these projects. As a result, there is no need for artificial introduction of indicators that reflect social importance of the projects. This takes into account the responsibility of the organization to its stakeholders.

The study (Mazelis & Solodukhi 2012) offered one-period models of optimization of the project portfolio under the investment development program, taking into account corporate social responsibility of the organization that adhered to stakeholder management as a discrete institutional alternative (on the example of a university).

The study (Mazelis & Solodukhin 2013) generalized one-period models for the case of several time periods, taking into account the fact that for the various strategic objectives, the speed of achievement has a different value to the organization. Thus, some of the objectives may require unconditional achievement by a certain date. Some strategic objectives "favor" the rapid growth of their level of achievement, while other objectives may prefer more moderate growth. On the other hand, resource cost and the difficulty of access to them in different periods can vary.

The study (Mazelis & Solodukhin 2014) demonstrated the use of the proposed multiperiod models (on the example of a university). In particular, it was shown that the risk limitation may lead to the fact that the portfolio does not include projects whose budgets allow this (given the limitations on the overall cost).

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This article is devoted to the modification of these models in two directions. Firstly, the revision of the composition of the previously selected project portfolio is allowed at each step, depending on the already achieved results and changes in internal and external conditions. Secondly, additional resource limitations for each time period are introduced.

2. Methodology

So, we continue to consider the problem of optimizing the development program of the organization, taking into account corporate social responsibility and resource constraints, volumes of investment and risks. This problem is seen as a problem of portfolio investment (Markowitz 1952, Sharpe 2000).

The central element of the strategy of any social and economic system is a system of strategic objectives. The system of objectives is the core of the strategic process, which occurs only when the organization has strategic objectives (Barry 1987). None of the schools of strategic management disputed the fact that the company itself (as an object) cannot have objectives. Only subjects (animated thinking beings) have objectives, and they bring their own interests in the activities of the firm. The conflict revolves around the question whose interests the firm must (first) take into account (Gurkov 2007).

Let the organization have *N* projects $P_1, P_2, \dots, P_N$ affecting *K* strategic objectives $G_1, G_2, \dots, G_K$. Recall that $G_1, G_2, \dots, G_K$ are objectives of the top-level strategy card (objectives of the "stakeholder" perspective), the achievement of which is directly related to the satisfaction of the stakeholders (Solodukhin, 2009). In this regard, these objectives can be considered independent because there are no direct causal relationships between them (such relations are at the level of the underlying prospects).

At goal setting, the contradictory interests of stakeholders are taken into account (Clarkson 1995, Lugovoy *et al.* 2012a, Jensen 2001). At the same time, objectives have different significance (importance) in terms of the impact on the organization's mission. Weights of the objects $w_1, w_2, \dots, w_K$ can be defined using one of the methods described in (Lugovoy *et al.* 2012a, Andreychikov & Andreichikova 2000).

It is necessary to form an optimal project portfolio, taking into account the available resources of the organization, risks of projects and their utility.

L scenarios of possible changes in internal and external environment $S_1, S_2, \dots, S_L$ are considered, where $p_1, p_2, \dots, p_L$ are the probabilities of these scenarios.

Each of the P_n projects is described with the following indicators:

- levels of achievement of the objectives $A_n^l = \left(a_{n1}^l, a_{n2}^l, \dots a_{nK}^l\right)$ at the implementation of the project within the S_l scenario;
- volume of the B_n resources necessary for its realization.

It is expected that resources are invested in the project by unequal installments over *T* time periods, i.e. $B_n = \sum_{t=1}^{T} B_n^t$. In each period, there is an increase in levels of achievement of the relevant objectives. Thus, the sequences emerge:

$$\left(a_{nk}^{l1}, a_{nk}^{l2}, \dots, a_{nk}^{lT}\right), \sum_{t=1}^{T} a_{nk}^{lt} = a_{nk}^l, k = 1, \dots, K, n = 1, \dots, N, l = 1, \dots, L.$$

In the one-period models, the utility of the P_n project in the implementation of S_l scenario is understood as the integral index describing the level of achievement of objectives taking into account their significance:

$$u_n^l = \sum_{k=1}^{K} w_k a_{nk}^l. \tag{1}$$

At the same time, the concept of a specific utility of P_n project in the implementation of S_l scenario was introduced, which was calculated by the formula:

$$\tilde{u}_n^l = \frac{u_n^l}{B_n}. \quad (2)$$

In multiperiod models, the utility of the project depended on how growth of levels of achievement of the objectives by the periods occurred.

Each G_k objective in the framework of P_n project in the implementation of S_l scenario was assigned to $\left(a_{nk}^{l1}, a_{nk}^{l2}, \ldots, a_{nk}^{lT}, B_n'\right)$ set, where B_n' is the value of P_n project costs, adjusted to the initial moment of time.

For each such set, $\tilde{u}_{nk}^l$ was defined – the specific utility of P_n project with respect to the G_k objective in the implementation of S_l scenario. Then the overall specific utility of P_n project in the implementation of S_l scenario was calculated:

$$\tilde{u}_n^l = \sum_{k=1}^{K} w_k \tilde{u}_{nk}^l. \quad 3)$$

Recall that the definition of the value $\tilde{u}_{nk}^l$ at the $\left(a_{nk}^{l1}, a_{nk}^{l2}, \ldots, a_{nk}^{lT}, B_n'\right)$ set requires the construction of *T*+1-dimensional surface, which is an approximation (with the required accuracy) of the chart of the function $\tilde{u}_k = \tilde{u}_k\left(x_1, x_2, \ldots, x_T, z\right)$, regarded as a function of utility: $\tilde{u}_k \in [0,1]$, $x_t \in [0,1], t = 1, \ldots, T$, the interval of the variable *z* is defined by constraints on resources. The universal method of constructing such surfaces for the utility functions of an arbitrary number of variables (criteria) at any links between the criteria is given in (Lugovoy *et al.* 2012b). Overall, we need to build K surfaces (for each objective) and find $K \cdot N \cdot L$ values of $\tilde{u}_{nk}^l$ (for each of the K objectives for all the *N* projects for all the *L* scenarios) as the values of the utility functions at appropriate points.

Levels of achievement of the objectives in each period and, therefore, specific and general utilities $\tilde{u}_n^l$ are considered as random variables depending on a number of external and internal factors, which are functions of time. The dispersions of the general specific utilities $D\tilde{u}_n^l$ are used as a measure of risk.

Binary variable y_n is defined:

- y_n = 0, if the *n* project is not included in the development program of the organization;
- y_n = 1, if the *n* project is included in the development program of the organization.

The following scheme to analyze and construct the optimal portfolio was suggested:

- For each of the N projects under consideration, we define the costs in each of the *T* time periods under consideration and calculate the adjusted cost of the project.
- Determine the weight coefficients of K upper-level strategic objectives.
- For each objective, we build a surface that approximates the chart of a specific utility function, considered as a function of *T*+1 variables (criteria), where the first *T* criteria are a possible increase in the level of achievement of the objective in each of the *T* periods, while the last criterion is the adjusted cost of the project, which ensured growth of the level of achievement of the objective.
- We determine the set of $S_1, S_2, \ldots, S_L$ scenarios and estimate the probability of each of them $p_1, p_2, \ldots, p_L$, where $\sum_{l=1}^{L} p_l = 1$.
- For each scenario for each project, we define its specific utilities with respect to each specific purpose (with the help of the constructed surface) and calculate the general utility of the specific project by the formula (3).
- Find the expectation for the utility of the *n* project:

$$m_n = E(\tilde{u}_n^l) = \sum_{l=1}^{L} \tilde{u}_n^l p_l \; . \tag{4}$$

- and the elements of the covariance matrix of the specific utilities of the projects *i* and *j*:

$$v_{ij} = \sum_{l=1}^{L} (\tilde{u}_i^l - m_i)(\tilde{u}_j^l - m_j) p_l \; . \tag{5}$$

- Set limitations on available resources.
- Accept the utility of the portfolio as the value $m_{port} = \sum_{i=1}^{N} y_i m_i$, the portfolio risk – as the value

$$\sigma_{port}^2 = \sum_{i,j=1}^{N} y_i y_j v_{ij} \; .$$

Project portfolio was proposed to form using the following models.

Model one

The development program of the organization is formed by the criterion of the maximum expected utility under the specific restrictions on the amount of risk of the program (σ_0^2), and the volume of resources required to implement the program (B_0):

$$\begin{cases} \sum_{i=1}^{N} y_i m_i \to \max, \\ \sum_{i,j=1}^{N} y_i y_j v_{ij} \le \sigma_0^2, . \\ \sum_{i=1}^{N} y_i B_i' \le B_0. \end{cases} \tag{6}$$

Model two

The development program of the organization is formed by the criterion of the minimum program risk at the restrictions on the amount of resources required for the implementation of the program (B_0) and the value of the expected specific utility (m_0):

$$\begin{cases} \sum_{i,j=1}^{N} y_i y_j v_{ij} \to \min, \\ \sum_{i=1}^{N} y_i m_i \ge m_0, \\ \sum_{i=1}^{N} y_i B_i' \le B_0. \end{cases} \tag{7}$$

Now assume the possibility of revising the composition of the previously selected project portfolio at each step, depending on the already achieved results and changes in internal and external conditions.

The need to revise the composition of the project portfolio is due to the fact that weights of objectives and scenarios under consideration (their number and probability) may change under the new circumstances. At that, the specific utilities of the projects with respect to the each objective may also be affected. Accordingly, the general specific utilities of specific projects will change. The result may be a situation in which it is advisable to stop some of the projects. The released resources will allow including previously not selected projects in the portfolio.

Thus, it is proposed to analyze and construct the optimal portfolio using the above scheme at each step (in the beginning of each of the *T* time periods). Note that the planning horizon can be varied. You can reduce the number of time periods by one at each step. Then the sequences of the increments of levels of achievement of the objectives will be shorter by one at each step. Accordingly, the dimensions of utility functions will be less by one at each step, which are necessary to build to determine the specific utilities of the projects depending on the objectives. On the other hand, the number of time periods can remain the same ("rolling" planning).

In addition, let's introduce additional resource limitations for each time period in the models. This will allow to more fully taking into account the differences in the cost of resources and the difficulty of access to them in different periods. So, $B_0 = \sum_{t=1}^{T} B_0^t$, where B_0^t is the limitation on the amount of resources needed to implement the program in the t period.

Then the models of formation of the optimal portfolio will change as follows.

Model three:

$$\begin{cases} \sum_{i=1}^{N} y_i m_i \to \max, \\ \sum_{i,j=1}^{N} y_i y_j v_{ij} \le \sigma_0^2, \\ \sum_{i=1}^{N} y_i B_i^1 \le B_0^1, \ldots, \sum_{i=1}^{N} y_i B_i^T \le B_0^T. \end{cases} \quad (8)$$

Model four:

$$\begin{cases} \sum_{i,j=1}^{N} y_i y_j v_{ij} \to \min, \\ \sum_{i=1}^{N} y_i m_i \ge m_0, \\ \sum_{i=1}^{N} y_i B_i^1 \le B_0^1, \ldots, \sum_{i=1}^{N} y_i B_i^T \le B_0^T. \end{cases} \quad (9)$$

These models are still the problems of Boolean quadratic programming, for solution of which the numerical optimization software packages can be applied.

3. Results

We will demonstrate the use of the proposed models on the example of the practice of the Vladivostok State University of Economics and Service (VSUES). We will consider the three strategic objectives, their corresponding figures with the current and target values, and the corresponding ranges of adjusted costs, beyond which the utility is either zero (at a cost above the right boundary, regardless of the level of achievement of the objective), or one (at a cost below the left boundary while achieving the level one of achievement of the objective) (Table 1).

Table 1 – Strategic goals, indicators and adjusted costs

Strategic objective	Weight of the objective	Parameter of the objective	Current value	Target value	Range of adjusted costs (mln rub.)
Increase in the publication activity of academic staff	0.3	Number of publications per one adjusted rate of the full-time academic staff in journals with RSCI impact factor not less than 0.2	0.5	1.6	[9; 44]
Increase in the degree level of full-time academic staff	0.2	Proportion of full-time university academic staff holding a degree of candidate or doctor of sciences, to the total number of full-time academic staff adjusted to full rate	0.66	0.78	[17; 140]
Increase in the volume of funds attracted by the university academic staff	0.5	Volume of the funds attracted by the university academic staff on R&D per one adjusted rate of the full-time academic staff (thous. rub.)	70	210	[13; 40]

For simplicity and clarity, each target corresponds to exactly one parameter in the example. Thus, at the achievement (or exceeding) by the parameter of the target value, the level of achievement is equal to one (if in this case the adjusted costs do not exceed the left boundary of the range); if the value of the parameter remains at the current level (or worsens), the level of achievement is zero (regardless of the costs incurred). If the objective is described by several parameters, the tools described in the works (Lugovoy *et al.* 2012, Keeney & Raiffa 1993) can be used to determine the relationship between the values of the parameters and the level of achievement. Note also that sometimes the parameter surpassing the target value lowers the level of achievement of the objective. In this case, you can use the methods described in the works (Morozov 2013; Garina 2012, Keeney 1974).

Table 2 – Costs and results of the projects

Costs by periods *(mln rub.)*	Adjusted costs at a 10% discount rate *(mln rub.)*	SCENARIO	PERIOD	OBJECTIVE 1	OBJECTIVE 2	OBJECTIVE 3
PROJECT 1						
8	13.95	Pessimistic	1	0.100	0.017	0
			2	0.100	0.033	0
		Realistic	1	0.117	0.033	0.010
8			2	0.150	0.050	0.010
		Optimistic	1	0.133	0.050	0.017
			2	0.183	0.050	0.017
PROJECT 4						
10	15.86	Pessimistic	1	0.050	0.033	0.083
			2	0.050	0.083	0.083
		Realistic	1	0.060	0.050	0.100
8			2	0.083	0.117	0.117
		Optimistic	1	0.067	0.067	0.117
			2	0.100	0.133	0.133

For each objective, we build a surface, which is an approximation of the chart of the function of specific utility, regarded as a function of three variables (criteria), where the first two criteria are a possible increase in the level of achievement in each of the two periods, and the third criterion is adjusted costs. Let's consider the nine strategic measures (projects), implementation of which over two periods (two years each) will contribute to achievement of the selected objectives:

- Establishment and operation of the reward system for academic staff having publications in top journals.
- Establishment and operation of support systems for young scientists, including those under the "Talent Pool" program.
- Establishment and operation of the motivation system for academic advisers and graduate students.

- Establishment and operation of the system to attract top scientists to the university staff.
- Establishment of a flexible system of requirements for enrollment to the acidic staff on a competitive basis, motivating to increase the productivity of scientific activity.
- Establishment and operation of the involvement of students in R&D since first years with the restructuring of the educational process.
- Establishment and operation of the system to raise the academic mobility of academic staff.
- Establishment and operation of the system to attract academic staff to student internships in enterprises in the framework of practice-integrated learning.
- Establishment and operation of improving the image of the university academic staff in the environment.

We will also consider three scenarios of possible changes in internal and external environment (let's call them pessimistic, realistic and optimistic) with probabilities 0.3; 0.6; 0.1, respectively. We will define the required costs for the periods for each project (and thus calculate the adjusted costs) as well as the sequence of increment levels to achieve the objectives by the periods for each scenario.

Table 2 shows an example of the data corresponding to the first and fourth projects. For each goal, using an appropriate constructed surface, we will define 27 values of the specific utility: for each of the nine projects for three scenarios (total of 81 values for all three objectives). Then we will calculate the general specific utilities of the projects in the implementation of each scenario and expectancy of utilities of the projects (Table 3).

Table 3 – General specific utilities of the projects

Project no.	General specific utility of the project			Expectancy of utility of the project
	SCENARIO 1 ($p_1 = 0{,}3$)	SCENARIO 2 ($p_2 = 0{,}6$)	SCENARIO 3 ($p_3 = 0{,}1$)	
1	0.056	0.086	0.105	0.079
2	0.036	0.052	0.069	0.049
3	0.063	0.089	0.117	0.084
4	0.125	0.146	0.165	0.142
5	0.091	0.127	0.152	0.118
6	0.025	0.046	0.066	0.042
7	0.049	0.081	0.114	0.075
8	0.108	0.142	0.167	0.134
9	0.060	0.095	0.118	0.087

Next we construct a covariance matrix of specific utilities of the projects and simulate the formation of the program of the university development, setting resource limitations. Table 4 shows some results of the use of the first model, when the university development program is formed by the criterion of the maximum expected specific utility with limitations on themamount of risk of the program and resources.

Table 4 – Simulation of the university development program (maximization of the expected utility, model one)

Limitations on the general adjusted costs *(mln rub.)*	Limitations on the risk of the project portfolio	No. of projects included in the portfolio	No. of projects not included in the portfolio	Expected utility of the project portfolio	Total adjusted costs of the project portfolio *(mln rub.)*
61.0	0.010	1, 3, 4, 5, 6, 8	2, 7, 9	0.60	52.0
	0.012	1, 3, 4, 5, 8, 9	2, 6, 7	0.64	50.2
	0.015	1, 3, 4, 5, 7, 8, 9	2, 6	0.72	58.6
	0.020	1, 3, 4, 5, 7, 8, 9	2, 6	0.72	58.6
65.8	0.010	1, 2, 3, 4, 5, 8, 9	1, 6, 7	0.61	60.7
	0.012	1, 3, 4, 5, 8, 9	2, 6, 7	0.64	50.2
	0.015	1, 3, 4, 5, 7, 8, 9	2, 6	0.72	58.6
	0.020	1, 3, 4, 5, 6, 7, 8, 9	2	0.76	65.5
91.9	0.010	1, 2, 3, 4, 5, 8	6, 7, 9	0.61	69.5
	0.012	1, 2, 3, 4, 5, 6, 8	7, 9	0.65	76.4
	0.015	1, 2, 3, 4, 5, 8, 9	6, 7	0.69	74.6
	0.020	1, 2, 3, 4, 5, 7, 8, 9	6	0.77	83.0
	0.021	All	-	0.81	89.9

Table 5 shows the results of the use of the second model, when the university development program is formed by the criterion of the minimum risk of the program with limitations on resources and the expected value of the specific utility.

Table 5 – Simulation of the university development program (minimization of risk, model two)

Limitations on the general adjusted costs *(mln rub.)*	Limitations on the expected utility of the portfolio	No. of projects included in the portfolio	No. of projects not included in the portfolio	Risk of the project portfolio	Total adjusted costs of the project portfolio *(mln rub.)*
61.0	0.4	2, 3, 4, 8	1, 5, 6, 7, 9	0.003	55.1
	0.5	2, 3, 4, 5, 8	1, 6, 7, 9	0.006	55.5
	0.6	2, 3, 4, 5, 8, 9	1, 6, 7	0.009	60.7
	0.7	1, 3, 4, 5, 7, 8, 9	2, 6	0.015	58.6
	0.75	Such utility can't be achieved			
65.8	0.4	2, 3, 4, 8	1, 5, 6, 7, 9	0.003	55.1
	0.5	2, 3, 4, 5, 8	1, 6, 7, 9	0.006	55.5
	0.6	2, 3, 4, 5, 8, 9	1, 6, 7	0.009	60.7
	0.7	1, 3, 4, 5, 7, 8, 9	2, 6	0.015	58.6
	0.75	1, 3, 4, 5, 6, 7, 8, 9	2	0.018	65.5
	0.8	Such utility can't be achieved			
91.9	0.4	2, 3, 4, 8	1, 5, 6, 7, 9	0.003	55.1
	0.5	2, 3, 4, 5, 8	1, 6, 7, 9	0.006	55.5
	0.6	1, 2, 3, 4, 5, 8, 9	6, 7	0.008	69.5
	0.7	1, 3, 4, 5, 7, 8, 9	2, 6	0.015	58.6
	0.8	All	-	0.020	89.9

Table 6 – Simulation of the university development program (maximization of the expected utility, model three)

Limitations on the general adjusted costs *(mln rub.)*	Limitations on the costs by periods *(mln rub.)*		Limitations on the risk of the project portfolio	No. of projects included in the portfolio	Expected utility of the project portfolio	Total adjusted costs of the project portfolio *(mln rub.)*
	1 period	2 period				
61.02	42.95	18.07	0.010	3, 4, 5, 6, 8, 9	0.607	43.2
			0.012	3, 4, 5, 7, 8, 9	0.641	44.6
			0.015	3, 4, 5, 7, 8, 9	0.641	44.6
			0.020	3, 4, 5, 7, 8, 9	0.641	44.6
	26.31	34.71	0.010	1, 4, 5, 6, 8, 9	0.602	42.9
			0.012	1, 4, 5, 7, 8, 9	0.636	44.3
			0.015	1, 4, 5, 7, 8, 9	0.636	44.3
			0.020	1, 4, 5, 7, 8, 9	0.636	44.3
65.80	35.80	29.98	0.010	1, 2, 4, 5, 8, 9	0.610	60.3
			0.012	1, 3, 4, 5, 8, 9	0.645	50.2
			0.015	1, 3, 4, 5, 7, 8, 9	0.720	58.6
			0.020	1, 3, 4, 5, 7, 8, 9	0.720	58.6
	42.95	22.84	0.010	1, 3, 4, 6, 8	0.599	50.2
			0.012	3, 4, 5, 7, 8, 9	0.641	44.6
			0.015	3, 4, 5, 6, 7, 8, 9	0.682	51.6
			0.020	3, 4, 5, 6, 7, 8, 9	0.682	51.6

Table 6 shows some results of the use of the third model, when the university development program is formed by the criterion of the maximum expected specific utility with limitations on the amount of risk of he program and the volume of resources required to implement the program in each period. Various options of splitting the total budget by periods were considered, with all costs having been reduced to the initial instant of time at the same discount rate (10%).

Let's now consider the procedure for the revision of the university development program after the first two-year period. As before, we will consider two periods of two years each (rolling planning).

As a result of the university development in the first period and on the basis of the changed internal and external conditions, the weights of objectives are revised (let them now be 0.2, 0.15 and 0.65, respectively), as well as the probabilities of scenarios (0.35, 0.55, 0.1). Note that, generally speaking, the number of scenarios under consideration may also change. In this example, for the purpose of simplicity, we will not change the number of scenarios.

We define new specific utilities of the projects in relation to each objective (for which we build new relevant surfaces), calculate the general specific utilities of the projects for each scenario and expectancies of the project utilities (Table 7).

Table 7 – General specific utilities of the projects after the end of the first period

Project no.	General specific utility of the project			Expectancy of utility of the project
	Scenario 1 $(p_1 = 0{,}35)$	Scenario 2 $(p_2 = 0{,}55)$	Scenario 3 $(p_3 = 0{,}1)$	
1	0.029	0.059	0.079	0.051
2	0.027	0.041	0.060	0.038
3	0.050	0.077	0.111	0.071
4	0.144	0.173	0.193	0.165
5	0.097	0.136	0.168	0.125
6	0.021	0.045	0.071	0.039
7	0.046	0.079	0.118	0.071
8	0.160	0.199	0.224	0.188
9	0.101	0.145	0.172	0.133

We build a new covariance matrix of specific utilities of the projects and simulate the formation of a new university development program, for example, using the first model. Some results are presented in Table 8.

Table 8 – Simulation of the university development program after the end of the first period (maximization of the expected utility, model one)

Limitations on the general adjusted costs *(mln rub.)*	Limitations on the risk of the project portfolio	No. of projects included in the portfolio	No. of projects not included in the portfolio	Expected utility of the project portfolio	Total adjusted costs of the project portfolio *(mln rub.)*
61.0	0.010	2, 4, 5, 8, 9	1, 3, 6, 7	0.65	46.4
	0.012	3, 4, 5, 8, 9	1, 2, 6, 7	0.68	36.2
	0.015	1, 3, 4, 5, 8, 9	2, 6, 7	0.73	50.2
	0.020	1, 3, 4, 5, 7, 8, 9	2, 6	0.80	58.6
65.8	0.010	2, 4, 5, 8, 9	1, 3, 6, 7	0.65	46.4
	0.012	3, 4, 5, 8, 9	1, 2, 6, 7	0.68	36.2
	0.015	2, 3, 4, 5, 8, 9	1, 6, 7	0.72	60.7
	0.020	1, 3, 4, 5, 7, 8, 9	2, 6	0.80	58.6
91.9	0.010	2, 4, 5, 8, 9	1, 3, 6, 7	0.65	46.4
	0.012	3, 4, 5, 8, 9	1, 2, 6, 7	0.68	36.2
	0.015	2, 3, 4, 5, 8, 9	1, 6, 7	0.72	60.7
	0.020	2, 3, 4, 5, 7, 8, 9	1, 6	0.79	69.0
	0.022	1, 2, 3, 4, 5, 6, 8, 9	7	0.81	81.6
	0.025	1, 2, 3, 4, 5, 7, 8, 9	6	0.84	83.0
	0.030	All	-	0.88	89.9

4. Discussion

As can be seen from Table 4, limitations on risk may lead to the fact that the portfolio does not include projects whose budgets allow doing this (at the set limitations on the general adjusted costs). For example, at the limitations on the general adjusted costs 65.8 mln rub. and limitations on risk 0.012, the total adjusted costs of the selected projects are 15.6 mln rub. less than the set limitation. At the same time, the adjusted costs of the sixth and seventh projects not included in the portfolio are 7.64 mln rub. and 9.16 mln rub., respectively. However, the inclusion of these projects in the portfolio would have increased the risk higher than the set limitation. In turn, changes in limitations on the risk (at the same limitation on the general costs) may result in the exclusion of certain projects from the portfolio and the inclusion of new projects.

The results presented in Table 6 show that the imposition of limitations on the costs by periods (model three) in most cases leads to the selection of other project portfolios, utility of which is not greater than the utility of the optimal project portfolio formed when solving the task with a limitation on the general costs for all periods (model one). Thus if we consider the various options for limitations by the periods (options of splitting the total budget), it is easy to see that the utility of each formed portfolio (at all the considered limitations on risk) within one of the options exceeds the utility of the relevant portfolio formed at the same limitation on risk in another option. For example, let's consider two options of limitations by periods under the general adjusted budget of 61.02 mln rub. The first option is 42.95 and 18.07 mln rub. The second version is 26.31 and 34.71 mln rub. For each of the four considered limitations on risk (0.010; 0.012; 0.015 and 0.020), the utility of the portfolio in the first scenario exceeds the utility of the corresponding portfolio in the first option.

Comparison of the results presented in Tables 8 and 4 shows that under the same limitations on the general costs and risk, changes in the internal and external conditions may alter the feasibility of inclusion of certain projects in the portfolio. For example, initially, when the limitations on the general adjusted costs were 65.8 mln rub. and risk – 0.020, the portfolio included all projects except the second, while after the first period (at the same limitations), the sixth project should be excluded from development program. The expected utility of the portfolio will only increase.

Conclusion

The proposed modified multiperiod optimization models allow the rolling planning of the portfolio, taking into account the risks in the framework of the strategic development of the organization. Corporate social responsibility of the organization is shown at setting goals, taking into account the interests of all stakeholders. The main difference between the proposed models is the ability to revise the composition of the previously selected project portfolio at each step, depending on the already achieved results and changes in internal and external conditions. Another important difference is the introduction of additional resource constraints for each time period.

The following areas for further research in this area can be allocated. Firstly, it is intended to develop a model to optimize the distribution of the total budget of the organization development program by periods. Secondly, the procedure of redeployment of resources between projects can be offered, in which some projects are not excluded from the portfolio at the changes in internal and external conditions (and, consequently, at the reduction in their utilities), but their funding is reduced. Freeing up resources could increase funding for other projects of the portfolio, or new projects can be incorporated in the development program.

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References

[1] Andreychikov, A.V., Andreichikova, O.N. (2000). Analysis, Synthesis, Planning Decisions in the Economy. Moscow: Finance and Statistics.

[2] Barry, D. (1987). The Relationship of Strategic Goals and Planning Processes to Organizational Performance (Unpublished Doctoral Dissertation). University of Maryland.

[3] Clarkson, M.E. (1995). A Stakeholder Framework for Analyzing and Evaluating Corporate Social Performance. Academy of Management Review, 20(1): 92 –118. DOI: 10.2307/258888.

[4] Garina, M.I. (2012) Multiplicative Convolution Application to Attributes Having both Negative and Positive Utility Values. *SPIIRAS Proceedings,* 3:176-188.

[5] Gurkov, I.B. (2007). Intergrated Metrics of Strategy Process — an Attempt of Theoretical Synthesis and Empirical Validation. *Russian Management Journal,* 5(2): 3-28.

[6] Jensen, M.C. (2001). Value Maximization, Stakeholder Theory, and the Corporate Objective Function. *Journal of Applied Corporate Finance*, 14(3): 8-21. DOI: 10.1111/j.1745-6622.2001.tb00434.x

[7] Keeney, R.L. (1974). Multiplicative utility functions. *Operations Research*, 22(1): 22–34. DOI: 10.1287/opre.22.1.22

[8] Keeney, R.L., Raiffa, H. (1993). Decisions with Multiple Objectives–Preferences and Value Tradeoffs. Cambridge & New York: Cambridge University Press. DOI: 10.1002/bs.3830390206

[9] Lugovoy, R.A., Mazelis, L.S., Solodukhin, K.S. (2012a). A Conceptual Model of Value Apportioning Among Organization's Stakeholders. *Management Review: An International Journal*, 1: 4-16.

[10] Lugovoy, R.A., Solodukhin, K.S., Chen, A.Y. (2012b). Models for Supporting Strategic Decision Making in College. *University Management: Practice and Analysis,* 4: 26-34.

[11] Maltseva, G.I. (Eds.). (2009a). On route to the Socially Responsible University. Vladivostok: the VSUES Publishing House.

[12] Maltseva, G.I. (2009b). The Role of Universities in Fashioning a Socially Responsible Society. The territory of new opportunities. *The Vladivostok State University of Economics and Service Bulletin*, 1: 9-21.

[13] Markowitz, H.M. (1952). Portfolio Selection. *Journal of Finances,* 7(1): 77-91. DOI:10.1111/j.1540-6261.1952.tb01525.x

[14] Mazelis, L.S., Solodukhin, K.S. (2012). The University Projects Portfolio Optimization Models Involving Risks and Corporate Social Responsibility. *University Management: Practice and Analysis*, 4: 53-56.

[15] Mazelis, L.S., Solodukhin, K.S. (2013). Multi-Period Models for Optimizing an Institution's Project Portfolio Inclusive of Risks and Corporate Social Responsibility. *Middle-East Journal of Scientific Research*, 17(10): 1457-1461. DOI: 10.5829/idosi.mejsr.2013.17.10.12320

[16] Mazelis, L.S., Solodukhin, K.S. (2014). Multi-Period Models for Optimizing a University's Project Portfolio Inclusive of Risks and Corporate Social Responsibility. *University Management: Practice and Analysis*, 6: 49-56.

[17] Morozov, V.O. (2013). The Formalization of the Relationship between the Level of Achievement of Strategic Objectives and Values of Its Indicators Based On the Alternating Utility Function. *Modern Problems of Science and Education,* 6. Retrieved from www.science-education.ru/113-11179. DOI: 10.17513/spno.2013.6

[18] Sharpe, W.F. (2000). Portfolio Theory and Capital Markets. New York: McGraw-Hill. DOI: 10.2307/2978700

[19] Solodukhin, K.S. (2009). The Set-up of the System of Balanced Indicators in a Stakeholder Company. *Controlling*, 2: 64-69.