КОРАБЛЕБУДУВАННЯ

УДК 005.8:519.87

Garbuz S.K.
Admiral Makarov National University of Shipbuilding

Titov S.D.
Admiral Makarov National University of Shipbuilding

THE STAKEHOLDERS' MANAGEMENT OF THE EDUCATIONAL PROJECT BASED ON THE APPLICATION OF OPTIMAL STRATEGIES FOR MATRIX GAME

In this article we have researched the features of the choice and application of optimal strategies in the game models of stakeholders' management of the education project on the base of the matrix game. Taking into acount all the possible scenarios of stakeholders' actions in the project, the payment matrix and significant combinations of the key factors have been considered. The problem of providing the regional labour market with specialists in the engineering, technical and vocational direction has been studied.

Key words*: educational project, resource sharing, regional labor market, management of stakeholders, payment matrix.*

Introduction. The Ministry of Education and Science has elaborated a draft: «Strategy for the Reform of Higher Education in Ukraine by 2020». The goal of the reform is to create a competitive national system of higher education,to transform universities into centres of independent thought, to provide fair competition between institutions of higher education as a guarantee of high quality of higher education, and also to create an appropriate link between the labour market and the system of higher education. The main challenges of the higher education system are the need to provide the training of skilled professionals for the labour market, to transform the economic model into a «knowledge-based economy», the need for higher education institutions to train professionals to meet labor market requirements, and to increase practical skills for graduates.

Formulation of the problem and analysis of recent research and publications. Since a significant number of potential entrants are currently leaving to study abroad, and graduates of Ukrainian universities are not employed according to their specialty, there is a shortage of labour resources in working and engineering specialties at the enterprises of the regions of the country. In this regard, it is necessary to monitor the demand of personnel with vocational and engineering education in the leading manufactoring and industrial enterprises and sectors of the region. As an interested party, the University can use the information lever of the impact on young people studying in colleges, comprehensive schools and vocational schools, orienting them to the regional labour market, offering educational services in the field of specialty and specialization.

The success of the implementation of such projects depends on the mutual expectations of universities and other project participants. There is a need to develop and evaluate options for possible scenarios for an educational project. The latest edition of the PMBOK Guide has been added with a new area of knowledge «The stakeholders' management of the project» – this indicates the relevance of the research in this area.

The analysis of publications shows that «the relations that are made between stakeholders and the resources that they possess are largely determined by national, social and economic peculiarities, therefore, even existing developments require adaptation to Ukraine's conditions». The analysis of approaches to the definition of stakeholders of projects implemented in higher education institutions [2] has been carried out.

The monograph [3] has developed a methodological approach to choosing the strategies of cooperation between universities with each of the interested parties, taking into account possible scenarios of interaction between the stakeholder groups among themselves. It has been shown that scenarios allow us to analyze and plan non-standard situations and to understand under which conditions a favorable or unfavorable situation may arise. The scenario helps to assess the ways how we can and should influence the processes that lead to acceptable and unacceptable measures for the organization.

The combination of strategies, according to the authors, allows you to simulate any situation in the project, as well as the bases for using the game models through characterization and repetition. The options for combining strategies for player behavior are determined by the terms of a specific project environment: relationship between the stakeholders, experience and knowledge of the project manager, company or team standards, requirements declared in the project charter, etc. [4].

Scientifically grounded methods are required for competent solving of problems with conflict situations. Such methods are developed by the mathematical theory of conflict situations, which is called the theory of games. The purpose of the theory of games is to determine the optimal strategy for each player [5].

The purpose of this work is to develop and research the model of the stakeholders' management of the educational project on the base of the application of optimal matrix game strategies. The results of the research will be used to identify the stakeholders, to develop and evaluate scenarios of their actions in a study project, as well as select the most effective one.

Presentation of the main research material. Through a survey of employees, interviews with the personnel department of enterprises and institutions of the region and a written request to their management, we find out the demand of specialists in engineering and technical direction for further employment at the enterprises of the city and region. With such information and connections with manufacturing, it is imperative to reach out to potential students of higher educational institutions, having worked in higher educational institutions of the 1st and 2nd levels of accreditation and secondary school, involving the leading scientific and pedagogical staff of the university, as well as successful graduates. Measures to popularize such professions can raise the level of prestige among entrants.

National University of Shipbuilding, a powerful educational institution that offers and provides education to obtain a Bachelor's degree in 27 specialties and 46 specializations, Master's Degree in 21 specialties and 59 specializations. The state university, on the one hand, is the subject of society and the state and is represented as a center of education, science and culture that meets the needs of society and fulfills state orders for the training of specialists and the pursuit of fundamental scientific research. On the other hand, it is the subject of a market economy as a producer of intellectual products and educational services and freely sells his products on the labour market [6]. Satisfying the requirements of stakeholders, the university receives from them the resources necessary for its functioning, and transfers them the resources of the university. Thus, the relationship between the higher educational establishment and stakeholders is built around resource sharing.

Offering new educational services, the university focuses on the regional labour market and the popularity of specialties and specializations among entrants.

To consider possible scenarios for the project and the diversity of stakeholders' interests in the matrix game, it is necessary to consider all the significant combinations, making a payment matrix for them.

Let the project have 4 alternative strategies:

1. The stake for specialization ***A***, the stake for the use of internal resources of higher educational institutions.

Table 1

Matrix of preferences of choice of combinations

Situation	Entrants	Internal resources	External resources
1	A	A	A
2	A	A	B
3	A	B	A
4	A	B	B
5	B	A	A
6	B	A	B
7	B	B	A
8	B	B	B

2. The stake for specialization ***A***, the stake for the use of external resources.

3. The stake for specialization ***B,*** the stake for the use of internal resources of higher educational institutions.

4. The stake for specialization ***B***, the stake for the use of external resources.

We consider the choice of the three project stakeholders in relation to the specialization ***A*** or ***B***: the entrants, the internal resources of universities, and external resources.

There are 8 variants of the situation, which is a combination of the benefits of stakeholders in relation to specialization (table 1).

Make a payment matrix, where the value is given in the conventional monetary units.

The values of the matrix represent the amount of net profit (in some conditional units) that the higher education institution will receive when implementing a particular strategy in a particular situation. Thus, for example, the largest amount of profit can be obtained by promoting specialization, the advantage of which will be given by entrants, while at the same time, the rate on external resources (which will cost universities more cheaply internally), subject to their interest in this specialization. These include assignments of the faculty for conducting classes and consultations at the university's branches and educational and consulting points located at a considerable distance from the main institution (Kyiv, Odesa, Kherson, Kirovograd region of Ukraine, as well as Batumi, Georgia), if we use external resources for this activity, then we will receive the budget savings of the special fund of higher educational institutions.

Internal resources are more expensive, but their use is less risky. In calculating profits we have taken into account not only the number of entrants who manage to attract in a particular situation, but also their outflow as a result of reluctance to continue their studies due to inconsistency of the quality level of education with initial expectations.

We find a solution to the problem assuming that the probability of each situation is the same.

It is assumed that each player can choose only one of the finite sets of their actions. The choice of action is called *the choice of player strategy*.

If each player chooses his strategy, then these two strategies are called *the game's situation*. The net strategy of player I is to choose one of *n* lines of the matrix of winnings ***A***, and the player strategy II is the choice of one of the columns of the same matrix. At the same time, each player knows which strategy is chosen by his opponent.

1. Check whether the payment matrix (table 2) has a saddle point. If so, then we write out the decisions of the game in pure strategies.

We believe that Player I chooses his strategy to maximize his winnings, and player II chooses his strategy so as to minimize the winner of player I.

We find a guaranteed win, which is determined by the lower price of the game a = max (ai) = 80, which indicates the maximum net strategy A2.

The upper price of the game b = min (bj) = 400.

That indicates the absence of a saddle point, since $a \neq b$, then the price of the game is within $80 \leq y \leq 400$.

2. We find solutions to the game in mixed strategies.

The mathematical models of a pair of dual linear programming problems can be written as follows: find the minimum of the function F (x) with restrictions (for player II):

$450x1+600x2+50x3+70x4 \geq 1$

$450x1+400x2+50x3+120x4 \geq 1$

$300x1+600x2+100x3+70x4 \geq 1$

$300x1+400x2+300x3+350x4 \geq 1$

$200x1+300x2+350x3+450x4 \geq 1$

$200x1+200x2+350x3+550x4 \geq 1$

$60x1+130x2+400x3+450x4 \geq 1$

$60x1+80x2+400x3+550x4 \geq 1$

$F(x) = x1+x2+x3+x4 \rightarrow$ in

Find the maximum of the function Z (y) with restrictions (for player I):

$450y1+450y2+300y3+300y4+200y5+200y6+60y7+60y8 \leq 1$

$600y1+400y2+600y3+400y4+300y5+200y6+130y7+80y8 \leq 1$

$50y1+50y2+100y3+300y4+350y5+350y6+400y7+400y8 \leq 1$

$70y1+120y2+70y3+350y4+450y5+550y6+450y7+550y8 \leq 1$

$Z(y) = y1+y2+y3+y4+y5+y6+y7+y8 \rightarrow max$

Table 2

Payment matrix of the game

Strategies/Situations	1	2	3	4	5	6	7	8
1	450	450	300	300	200	200	60	60
2	600	400	600	400	300	200	130	80
3	50	50	100	300	350	350	400	400
4	70	120	70	350	450	550	450	550

Solve the direct problem of linear programming by a simplex method, using a simplex table.

Determine the maximum value of the *objective function* Z (Y) y1 + y2 + y3 + y4 + y5 + y6 + y7 + y8 under these conditions-restrictions.

$450y1+450y2+300y3+300y4+200y5+200y6+60y7+60y8\leq 1$

$600y1+400y2+600y3+400y4+300y5+200y6+130y7+80y8\leq 1$

$50y1+50y2+100y3+300y4+350y5+350y6+400y7+400y8\leq 1$

$70y1+120y2+70y3+350y4+450y5+550y6+450y7+550y8\leq 1$

To construct the first reference plan, we introduce the system of inequalities to the system of equations by introducing additional variables (transition to canonical form).

$450y1+450y2+300y3+300y4+200y5+200y6+60y7+60y8+y9 = 1$

$600y1+400y2+600y3+400y4+300y5+200y6+130y7+80y8+y10 = 1$

$50y1+50y2+100y3+300y4+350y5+350y6+400y7+400y8+y11 = 1$

$70y1+120y2+70y3+350y4+450y5+550y6+450y7+550y8+y12 = 1$

We solve the system of equations with respect to the basis variables: y9, y10, y11, y12. Assuming that the free variables are equal to 0, we get the first reference plan:

Y0 = (0,0,0,0,0,0,0,0,1,1,1,1) (table 3).

We turn to the main algorithm of the simplex method.

Iteration № 0.

1. Verification of the criteria of optimality.

The current support plan is not optimal because there are negative coefficients in the index line.

2. Definition of a new basic variable.

As the main one, select the column corresponding to the y8 variable, since it is the largest modulus factor.

3. Definition of a new free variable.

Calculate the value of Di in terms of the fraction of the division: bi / ai8

and one of them will choose the least: min (1: 60, 1: 80, 1: 400, 1: 550) = 1/550

So, the fourth line is the main thing.

The solution element is (550) and is located at the intersection of the main column and the main line.

4. Recalculation of the simplex table.

We form the next part of the simplex table. Instead of the variable 12, plan 1 will include the variable y8. We get a new simplex table. Perform some iteration.

The final version of the simplex table, when the index line (fig. 1) does not contain negative elements, the optimal plan is found:

Optimal mixed strategy of player I:

P = (0; 11/20; 0; 9/20)

Optimal mixed strategy of player II:

Q = (0; 0.533; 0; 0; 0; 0; 0.467; 0)

Game price: **v**=274

Xa = [0; 11/20; 0; 9/20]

Yb= [0; 0.533; 0; 0; 0; 0; 0.467; 0]

The essence of the simplex-method, in that the movement to the optimum point is carried out from one corner point to another, which can approach to the *Xopt*- closer and faster. Such a scheme of crossing points, called the simplex method, was proposed by the American mathematician George Danzig.

So, from a practical point of view, we can conclude that it is more profitable for a player to have more strategies because it provides additional flexibility to the project manager. Also, if pure strategies

Table 3

Supporting plan

Базис	B	y1	y2	y3	y4	y5	y6	y7	y8	y9	y10	y11	y12
y9	1	450	450	300	300	200	200	60	60	1	0	0	0
y10	1	600	400	600	400	300	200	130	80	0	1	0	0
y11	1	50	50	100	300	350	350	400	400	0	0	1	0
y12	1	70	120	70	350	450	550	450	550	0	0	0	1
Z(Y0)	0	-1	-1	-1	-1	-1	-1	-1	-1	0	0	0	0

Z(Y6)	0.00365	175/548	0	175/548	207/548	187/548	167/548	0	35/548	0	11/5480	0	9/5480

Fig. 1. A fragment of the index line of a simplex table

allow you to choose the logic of behavior that ensures the most stable implementation of the project, then mixed strategies help control the balance of power and stakeholder contributions to different attitudes towards the project and its product [7].

Conclusions.

1. The formalization of the task of choosing the optimal strategy of the stakeholders of the educational project has been carried out.

2. The elements of the payment matrix are proposed to consider alternative scenarios and project situations that are a combination of key factors.

3. The disadvantage of the approach is the combinatorial complexity of the task, which complicates the simultaneous consideration of a large number of factors.

4. Further research in this area should be aimed at developing mechanisms for assessing winnings in certain scenarios in certain situations.

References:

1. Strategy of the Ukraine higher education reformation up to 2020 year (the project) Kiev, 2014. URL: http://osvita.ua/vnz/reform/43883/ (date of calling is 28.02.2018).

2. Guseva U., Kantsevich M., Chumachenko I. Multi-stakeholder model of the educational project quality management . Herald of the National Technical University «CPI». Collection of the scientific articles. Series: Strategic management, portfolio, programs and projects management. Kharkov: NTU «CPI». 2015. № 2(1111). P. 8-13.

3. Gresko A., Solodukhin K., Models and methods of the university and the stakeholders interaction strategies choice in the condition of the uncertainty. Study. URL: portfolio.vvsu.ru/files/ (date of calling is 16.02.2018).

4. Grigorian, T.G., Titov S.D., Gayda A.Y., Koshkin V.K. A game-theoretic approach to harmonization the values of project stakeholders. Proceedings of the XII-th International Scientific and Technical Conference: Computer Sciences and Information Technologies, CSIT 2017. P. 527-530.

5. Research of the procedures in economics: Workbook for University/ Kremer N., Putko B., Trishin I., Fridman M. / edited by professor N. Kremer. Moscow, 2005. 407 p.

6. In the way to the social responsible university / I. Bedrachuk et al. Vladivostok, 2009. 412 p.

7. Grigoryan T.G. Use of the bimatrix games in the harmonization of the project stakeholders value. Herald of NTU «CPI». Series: Strategic management, management of the portfolio, programmes and projects. Kharkov: NTU «CPI». 2017. № 3(1225). P. 35–42.

8. Guidance to the Code of Knowledge on the project management (Guidance PMBOK): ANSI/PMI 99-001-2004, American National Standard. USA, Project Management Institute, 2008. 464 p.

УПРАВЛІННЯ СТЕЙКХОЛДЕРАМИ НАВЧАЛЬНОГО ПРОЕКТУ НА ОСНОВІ ЗАСТОСУВАННЯ ОПТИМАЛЬНИХ СТРАТЕГІЙ МАТРИЧНОЇ ГРИ

У статті досліджено особливості вибору та застосування оптимальних стратегій в ігрових моделях управління стейкхолдерами навчального проекту на основі матричної гри. Під час розгляду можливих сценаріїв дій стейкхолдерів за проектом розглянуто суттєві комбінації ключових факторів та платіжну матрицю. Порушено проблему забезпечення регіонального ринку праці фахівцями з інженерно-технічного та професійно-технічного напряму.

Ключові слова: *навчальний проект, обмін ресурсами, регіональний ринок праці, управління стейкхолдерами, платіжна матриця.*

УПРАВЛЕНИЕ СТЕЙКХОЛДЕРАМИ УЧЕБНОГО ПРОЕКТА НА ОСНОВЕ ПРИМЕНЕНИЯ ОПТИМАЛЬНЫХ СТРАТЕГИЙ МАТРИЧНОЙ ИГРЫ

В статье исследованы особенности выбора и применения оптимальных стратегий в игровых моделях управления стейкхолдерами учебного проекта на основе матричной игры. При рассмотрении возможных сценариев действий стейкхолдеров по проекту рассмотрены существенные комбинации ключевых факторов и платежную матрицу. Поднят вопрос обеспечения регионального рынка труда специалистами инженерно-технического и профессионально-технического направления.

Ключевые слова: *учебный проект, обмен ресурсами, региональный рынок труда, управление стейкхолдерами, платежная матрица.*