An Analysis and Evaluation of the Effectiveness of Decision Making During the Review of Scientifically Constructed Project Proposals

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Abstract

A selection technique for innovative projects on the beginning stage has been presented in this article. It can be applied in projects assessment in HEI, enterprises, development institutes, etc. It is rather difficult to assess the project quality on the beginning stage of R&D due to the uncertainty in the technical and economic indices but the new development analysis on this stage is of a great interest. By innovative project quality as a management object we will mean those characteristics relating to the results capacity of the projects and its realization process to satisfy the requirements to the innovative products competitiveness and their innovative attractiveness for investors. The most important question in the innovative projects management is the determination of its quality level under modern conditions. The aim of the research is to analyze and evaluate the decision making during the project management process. The objectives and hypotheses are assessment of an innovative project with the application of McKinsey's model is better to realizes by 3 stages: a) selection of optimal criteria; b) determination of weighing coefficients; c) projects positioning in a matrix.

Keywords: criteria of competitiveness, innovative attractiveness.

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I. Introduction

On the basis of certain criteria we offer a technique of innovative projects expertise on the beginning stage. The technique is based on the model of American scientist McKinsey (Ansoff, 1989). In the development of this technique a methodological approach based on the expert assessment of innovative project competitiveness and innovative attractiveness has been applied. The adequacy of the criteria used in the relation to the complex index is formed due to the implementation of weighing coefficient to each criterion and the application of additive-multiplicative computing technique. The assessment of an innovative project with the application of McKinsey's model is better to realizes by 3 stages: a) selection of optimal criteria; b) determination of weighing coefficients; c)projects positioning in a matrix.

From the point of view of the market, innovative projects are the objects of its two interacting segments: science and business. That is why it is advisable to formalize them as two dimensional objects: competitiveness and innovative attractiveness. The peculiarity of these indices is in the dependence on many criteria. Below there are criteria that have the greatest impact on these indices (Efremov, 1998).

II. Criteria of competitiveness:

1)The sales market availability and the possibility to commercialize the results of the project;

2)The level of competitive advantage of R&D results and the possibility of their long maintenance;

3)Conformity with the existing distribution channels;

4)Patent ability (possibility to protect the project by a patent);

5)The availability of the intellectual property object;

6)The availability scientific and technological background;

7)The scopes and the spectrum of the technologies practical application;

8)The provision with the modern level of innovations management (project management techniques);

9)The level of project development;

10)The availability of the qualified team and work experience in the projects implementation;

11)The perspectives of attracting private funds (investment attractiveness);

12)The possibility to perform future R&D on the basis of the given project and new technologies(Goldshtein, 2003).

III. Criteria of innovative attractiveness:

1)The compliance of the project with the priority directions of industrial and innovative strategy;

2)The actuality of the research and product uniqueness (absence of analogies);

3)Scientific and technological level of the project;

4)The scientific novelty of the suggested in the project solutions;

5)Technological level of the project (technology transfer, new technology);

6)Technical feasibility of the project;

7)The cost of the project;

8)The project payback period;

9)The project advantages in comparison with the existing analogies in the world;

The compliance of the project with the priority directions of industrial and innovative strategy.

IV. Methodology

To calculate these criteria it is necessary to suggest a certain approach

(Ansoff, 1989). The simplest way for the solution of this task is connected with the determination of average values (Efremov, 1998), when:

$$P_j = \sum_{i=1}^{n} x_i f_{ij}, \sum_{i=1}^{n} x_i = 1 ,$$

$$K_j = \sum_{k=1}^{m} y_k g_{kj}, \sum_{k=1}^{m} x_k = 1 ,$$

$$P_{\min} \le P_j \le P_{\max} ,$$

$$K_{\min} \le K_j \le K_{\max} ,$$

where f_{ij} – the value of i–factor of j–object (project) for the index of attractiveness

x_i – the value of weighing coefficient of j–criteria for the innovative attractiveness index;

n – the number of criteria for the innovative attractiveness index;

g_{kj} – the value of k–criteria of j–object (project) for competitiveness index;

y_k – the value of weighing coefficient of k–factor for competitiveness index;

m – the number of factors for the competitiveness index;

J=1, J. J –the number of objects (projects);

Pmin, Pmax, Kmin, Kmax – minimum and maximum values of P and K.

McKinsey' s model is applied in the markets analysis on based on 2 indices (industry attractiveness and enterprise) where the field of indices is divided into 9 sectors (Efremov, 1998).

In our case to position each project it is necessary to determine their P and K indices which are the coordinates of these objects (projects) in the given matrix. In the model a weighing average factor (criteria) value is used to determine the coordinates. The values on each factor should be evaluated by the experts (from 1 to 5); at several experts the values are averaged.

For the formalization of criteria adjustment the most appropriate approach is the expert assessment containing a complex of logic and mathematic and

statistic procedure and based on the specialist knowledge. The ranking method was used for the determination and adjustment of weighing coefficient on each (Valdaitsev & Motovilov, 2004).

In ranking, the initial ranks are converted so that Rank 1 becomes Rank m, etc., and Rank n becomes Rank 1. According to theses converted ranks the sums are calculated (Shelobayev, 2001).

$$R_J = \sum_{K=1}^{M} R_{JK},$$

where RJ - the sum of converted ranks on all experts for j-factor;

RJK - converted rank given by k-expert to j-factor;

M, N - the number of experts and criteria, accordingly.

For the criteria weight (Fatkhutdinov, 1998):

$$W_J = R_J \div \sum_{J=1}^{N} R_J,$$

where WJ - an average criteria weight on all experts.

In McKinsey' s model an important component is the judgement matrix where the elements values are based not on the accurate measurements but on the subjective judgments (these matrices are prepared by the exerts). Judgment matrix (Goldshtein, 2003):

$$A = (a_{ij}),\ ij = 1,2,\cdots J$$

where aij - the figure equivalent to the object importance (P and K criteria).

Expert "quality" in filling in the judgment matrix is defined through the conformity relation (OS). The value OS≤0,1 are considered to be applicable [4]. For A matrix of judgement it required to find a maximum characteristic value λmax and a vector of characteristic value Z, i.e. it is necessary to solve an equation (Thompson & Strickled, 1998):

$$A*Z = Z - \lambda_{max}$$

The components of Vector Z are weighing coefficients.

V. Results and discussion section

In the questionnaire the scientists of EKSTU and other universities, "Altai" regional scientific and technological park, "Tsvetmet" research institute and the specialists of Ust-Kamenogorsk City production enterprises were involved as experts. In the qualitative ratio, the experts were the directors, R&D specialists, innovation managers (Goldshtein, 2003).

The questionnaire was made on the basis of the list of 2 criteria groups named before. The total number of questionnaires constituted 22 census papers. The experts were also offered to complement the given list or exclude some odd criteria from the list.

The criteria ranking was conducted by a simple way - by giving the highest rank to the criteria having the lowest value in their opinion. The importance (rank) of each criterion is determined according to the average assessment value and the sum of experts' assessment ranks.

The checking of experts' assessments conformity on the criteria was made by the coefficients calculations of factors variations which are the analogies of dispersion (Thompson & Strickled, 1998).

$$S_j = \frac{h}{h-1} \cdot \frac{\left(\sum_{j=1}^{k} f_{ij}\right)^2 - \sum_{j=1}^{k} {}^2 f_{ij}}{\left(\sum_{j=1}^{k} f_{ij}\right)^2},$$

where h - the number of experts.

As in our case the specialists-experts are from different industries and are not homogenous it is important to control their homogeneity. For the solution of this task on various criteria received from the experts, the conformity- concordance of their opinions has been determined. The concordance coefficient - W is calculated by a formula offered by Kendall (Shelobayev, 2001):

$$W = \frac{12 \cdot S}{m^2 \cdot \left(n^3 - n\right)},$$

where n - the number of factors;

m - the number of experts.

In case any expert is not able to define the rank difference between several neighboring factors and gives them equal ranks, the concordance coefficient calculation is made by the formula (Efremov, 1998):

$$W = \frac{S}{\frac{1}{12} m^2 (n^3 - n) - m \sum_{j=1}^{m} T_j},$$

where

$$T_j = \frac{1}{12} \sum_{t_j} (t_j{}^3 - t_j),$$

and t_j – the number of equal ranks in the j–range.

The values of the sum of diminution squares S was calculated by the formula (Valdaitsev & Motovilov, 2004):

$$S = \sum_{i=1}^{n} \left\{ \sum_{j=1}^{m} x_{ij} - \frac{1}{2} m (n+1) \right\}^2,$$

where x_{ij} – the rank of i–factor, given by j–expert.

m - the number of experts;

n –the number of factors (criteria).

The importance of W coefficients was checked for the 0,01 (99%) level on the powerful criteria x2, minimizing the error of the second type (accepting a wrong hypothesis), at an importance level α - the probability to discard a just hypothesis (the error of the first type) and number of degree of freedom f.

The value x2 - of statistics is calculated by the formula (Thompson & Strickled, 1998):

$$x^2 = mfW,$$

where m - the number of experts;

f - the number of degree of freedom f = k - 1,

W - concordance coefficient.

In case Value x2 - of statistics exceeds the critical value of x2 at the importance level α and the number of degree of freedom f, i.e.: $x^2 = mfW > x_{кр}(a; f)$, the hypothesis about the conformity of opinions is not rejected.

The experts' assessments on each group of criteria vary according to their importance. In Table 1 there concordance coefficients values on the innovative attractiveness and competitiveness criteria (Fatkhutdinov, 1998).

<Table 1> Concordance coefficients value

Indices	Innovative attractiveness criteria	competitiveness criteria
Average sum of ranks	-121	-143
the sum of diminution squares S	26175	40386
W- concordance coefficient	0,66	0,58
Sj-variation coefficient	0,92	0,93

Source: SPSS Analysis

The received concordance coefficients values testify that for each group of criteria (0,66; 0,58), concordance (0,5-0,7 - there is a noticeable interconnection of assessments between all the experts (Goldshtein, 2003).

Analyzing the results of experts evaluation of innovative attractiveness criteria at m = 15,f=11, α = 0,01 the value of x2 - of statistics is the following:

x2 = 15(12-1)* 0,319534=52,72311> x2 к р (0,01; 11) = 24,725.

Accordingly, the value of x2 - of results statistics of experts' evaluation of competitiveness criteria is

x2 = 15(12-1)* 0,41265=68,08725 > x2 к р (0,01;11)=24,725

As the value of x2 is more than x2 к р, consequently, the hypothesis of experts opinion concordance is not rejected (Fatkhutdinov, 1998).

The received experts' evaluations give the possibility to get weighing

coefficients for the determination of the further positioning of innovative projects in the matrix. At the third stage the project positioning with the application of McKinsey' s model is performed. As an example 2 projects have been prepared which should be assessed by the experts on the innovative attractiveness and competitiveness criteria (Goldshtein, 2003).

Specialists of R&D in different spheres were the experts. The experts prepared 2 tables (for the indices of innovative attractiveness and competitiveness) with the assessment of each project on each criterion (Fatkhutdinov, 1998). Average assessments of 5 experts for the indices of innovative attractiveness and competitiveness are given in Tables 2, 3.

At the second stage the weighing coefficients showing the importance of each criterion have been defined. For the index of innovative attractiveness the coefficients are: 0,185; 0,198; 0,082; 0,071; 0,074; 0,049; 0,046; 0,069; 0,038; 0,188. Consequently, the most important criterion is the research actuality and project uniqueness (absence of analogy), on the second place there is an economic feasibility of the project, on the third - the conformity of the project with the priority directions of industrial and innovative strategy, on the forth– scientific and technical level of the project, on the fifth– technological level of the project (technology transfer, new technologies), etc (Fatkhutdinov, 1998).

For the index of competitiveness the weighing coefficient values are equal to 0,276; 0,121; 0,034; 0,062; 0,071; 0,068; 0,050; 0,034; 0,043; 0,144; 0,058;0,039.Inthisgroupthecriteriaarepresentedinthefollowingsequence:onthefirstplace–the sales market availability and the possibility to commercialize the results of the project, on the second – The availability of the qualified team and work experience in the projects implementation, on the third – The level of competitive advantage of R&D results and the possibility of their long maintenance, on the forth – The availability of the intellectual property object, on the fifth – The availability scientific and technological background, etc (Fatkhutdinov, 1998).

<Table 2> Average assessments for the criteria of innovative attractiveness

Criteria	Innovative projects	
	Project No. 1	Project No. 2
1 The compliance of the project with the priority directions of industrial and innovative strategy	4,60	5,00
2 The actuality of the research and product uniqueness (absence of analogies)	2,40	4,00
3 Scientific and technological level of the project	2,20	3,00
4 The scientific novelty of the suggested in the project solutions	2,40	3,00
5 Technological level of the project (technology transfer, new technology)	2,40	3,00
6 Technical feasibility of the project	2,60	4,00
7 The cost of the project	2,20	4,00
8 The project payback period	3,20	4,20
9 The project advantages in comparison with the existing analogies in the world	2,60	2,40
10 The cost-effectiveness of the project	3,60	4,80

Source: SPSS Analysis

<Table 3> Average assessments for the criteria of competitiveness

Criteria	Innovative projects	
	Project No. 1	Project No. 2
1 The sales market availability and the possibility to commercialize the results of the project	1,80	4,80
2 The level of competitive advantage of R&D results and the possibility of their long maintenance	2,20	3,00
3 Conformity with the existing distribution channels	3,20	4,80
4 Patentability (possibility to protect the project by a patent)	3,00	4,00
5 The availability of the intellectual property object	3,40	5,00
6 The availability scientific and technological background	3,60	4,20
7 The scopes and the spectrum of the technologies practical application	2,00	3,60
8 The provision with the modern level of innovations management (project management techniques)	3,80	4,60
9 The level of project development	4,00	5,00
10 The availability of the qualified team and work experience in the project implementation	2,60	5,00
11 The perspectives of attracting private funds (investment attractiveness)	4,00	4,20
12 The possibility to perform future R&D on the basis of the given project and new technologies	3,60	3,20

Source: SPSS Analysis

With the help of received average assessment and weighing coefficients the innovative projects positioning has been performed in the matrix of McKinsey' s model (Goldshtein, 2003). The received weight and criteria assessments are given in Tables 4, 5.

<Table 4> The assessment of project №. 1 и №. 2 value on the indices of innovative attractiveness

Criteria of innovative attractiveness	Weights of the criteria	Regulated assessment of the vector of priority criteria on the project №1	Regulated assessment of the vector of priority criteria on the project №2
1	0,185	0,851	0,925
2	0,198	0,4752	0,792
3	0,082	0,1804	0,246
4	0,071	0,1704	0,213
5	0,074	0,1776	0,222
6	0,049	0,1274	0,196
7	0,046	0,1012	0,184
8	0,069	0,2208	0,2898
9	0,038	0,0988	0,0912
10	0,188	0,6768	0,9024
Total	1	3,0796	4,0614

Source: SPSS Analysis

<Table 5>

The assessment of project №. 1 и №. 2 value on the indices of competitiveness

Criteria of competitiveness	Weights of the criteria	Regulated assessment of the vector of priority criteria on the project №1	Regulated assessment of the vector of priority criteria on the project №2
1	0,276	0,4968	1,3248
2	0,121	0,2662	0,363
3	0,034	0,1088	0,1632
4	0,062	0,186	0,248
5	0,071	0,2414	0,355
6	0,068	0,2448	0,2856
7	0,050	0,1	0,18
8	0,034	0,1292	0,1564
9	0,043	0,172	0,215
10	0,144	0,3744	0,72
11	0,058	0,232	0,2436
12	0,039	0,1404	0,1248
Total	1	2,692	4,3794

Source: SPSS Analysis

The received matrix allows to position each innovative project according to the given criteria of innovative attractiveness and competitiveness in a certain sector. The borderline of the matrix are the maximum and minimum possible values - 1 and 5 respectively (Goldshtein, 2003).

It is important to note that the sectors names of McKinsey' s matrix in our case differ from the classical ones (Thompson & Strickled, 1998).

VI. Conclusions and recommendations

We defined 3 spheres: 1) □leaders□; 2) □outsiders□, 3) □bordering□.

The projects which after positioning are in the sphere of "leaders" have the best or average index values of innovative attractiveness and competitiveness and are of higher priority, they can be implemented right now (Ansoff, 1989).

Projects that are in 3 sectors in the lower left corner of the matrix ("outsiders") have low values on many criteria. These projects are problematic - they have more weaknesses than advantages.

3 sectors located along the main diagonal going from the lower left to the upper right edge of the matrix have the classical name "bordering" : they are competitive sector (in case of low attractiveness), attractive sector (in case of low competitiveness) and neutral sector. These projects are rather perspective and need further development.

As a solution we will take that alternative (project), where regulated assessment of the vector is located in sector "Leader 1" . Project №2 might be considered to be such an alternative which is of higher priority according to the experts' assessment and is ready for the implementation.

Project №1 takes a neutral position in the matrix, is a perspective but has certain disadvantages which should be worked out.

On the bass of the received criteria model and criteria weight assessment the requirements and techniques have been developed for the innovative projects expertise. It can be applied in projects assessment in HEI, enterprises, development institutes, etc.

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