MULTI-CRITERIA DECISION MAKING IN ECONOMY AND PREFERRED ALTERNATIVES SELECTION

Guzaliya S. Klychova*, Viktor P. Kuznetsov**, Dmitry N. Lapaev**, Olga N. Lapaeva**, Fayaz N. Avkhadiev***

*Kazan Federal University, Institute of Management, Economics and Finance, Kazan, 420008, Russia, Kazan State Agrarian University Kazan, 420015, Russia
**Kozma Minin Nizhny Novgorod State Pedagogical University, Nizhny Novgorod, 603950, Russia
***Kazan State Agrarian University Kazan, 420015, Russia

Abstract

The article considers methodological aspects and tools of decision-making in the economy by the aggregated indicators. It has outlined the main problems, which occur by the implementation of multi-criteria optimization. The authorial methods of the effective plurality formation and the preferred alternatives definition have been formulated.

Keywords: Multi-Criteria Optimization, Decision-Making, Effective Set, Preferred Alternative, Party Concerned, Economic Forecasting, Public Management, Corporate Governance

1. INTRODUCTION

Hypothesis of the article is that application of several indicators at making management decisions in economy enables to provide detailed estimation. Nevertheless, multi criteria quality significantly complicates the process of alternative comparison. It is explained by the ambiguity of indicators. Improvement of one of indicators will lead to the decrease of the others, optimum by each of them being reached in different points. Indicated condition introduces ambiguity into the selection process. For the purposes of similar tasks settlement it is necessary to use the relevant principals of multi criteria optimization and develop methodological tools.

In many countries, public administration reforms are carried out in the mainstream of the New Public Management (or in short - NPM). NPM requires the adaptive transfer of advanced business management techniques into the public sector of economy.

One common problem is in the way both of the NPM introduction, and the optimization of bureaucratic organization and is coupled with the objective performance assessment. The tools, which are contractual in their nature, as well as the improved regulations and rules of bureaucratic organization, contain performance criteria in an explicit or latent form (in the form of contracts, regulations or rules of operation). The interpretation of economic and other objectives and criteria authenticity, the adequacy of their performance actions reveals the bureaucracy quality (Burganova R.A., Novak V.V., Salahieva M.F., 2015).

2. THEORETICAL SUBSTANTIATION OF THE ISSUE

The proper enforcement of laws and rules serves as a primary criterion of performance in the traditional system, as they reflect the public need. However, the laws often allow a broad variation of definite actions, including those, which are lucrative to the managers, but not to the society. Formation of the law of direct action, specified procedures and rules, coordinated with the priorities, is a prerequisite for economic usefulness improving. Similarly, the terms of contracts within the NPM scope specified not quite clearly, cannot guarantee the desired results. Detailing and specification of tasks and conditions of their implementation is a key feature of the progress towards management by the results, whether in the traditional bureaucratic model or in the NPM model *(Burganova R.A., Novak V.V., Salahieva M.F., 2015).*

A major challenge in the field of the corporate governance is the competitiveness of economic entities in the context of global challenges and threats provision. Settlement of this problem requires introduction of complex changes in the elements of the internal environment of the corporation, optimization of a wide variety of criteria, the proper correction of organizational and administrative documents regulating the operation and development of the control system.

The effective management decision-making problem is the cornerstone for all countries, and its importance increases with the transition of economy to a new way due to the massive increase in costs for complex projects, programs, activities implementation in the various spheres of activity as well as due to limited resources. The term "alternative" in economics brings together a wide range of objects ranging from business units, business processes, functions, enterprises and organizations; and if we go further, sectors of economic activity, regions, federal districts, and ending up with the state as a whole. The alternatives are also understood as investment projects implemented by various economic entities

(Burganova R.A., Novak V.V., Salahieva M.F.,2015.; Georgina, A., Timea, G., Andras N., Zsolt C. 2013.; Glebova I.S., Mirsaitova A.A. 2013).

In practice, we usually distinguish between the analyses of one or several alternatives. In the first case we are talking about of a certain single object performances with some pivotal values. The latter can be: information of the previous years, the average values potentially achievable or maximum permissible levels and so on. In the second case, a joint analysis of alternatives set is understood as a benchmarking (*Tufetulov A.M., Davletshin T.G., Salmina S.V., 2015*)

Several interested parties (stakeholders) are usually involved in the current economic conditions of projects, programs and other activities implementation. The main stakeholders are (*Georgina, A., Timea, G., Andras N., Zsolt C., 2013*): public authorities, owners, managers, investors, creditors, employees, suppliers, customers, industry enterprises, in-infrastructure companies and so on.

The scientific and economic literature usually distinguishes one-criterion from the multi-criteria problems (*Burganova R.A., Novak V.V., Salahieva M.F., 2015*). In the first case, the alternatives are described by a single performance indicator. The use of multiple indicators is intended to provide a multidimensional assessment. However, the aggregate figures significantly complicate benchmarking of alternatives. This is explained by the presence of conflicting indicators, i.e. their use fails to focus an aggregate result. Improvement of one of the indicators leads to deterioration of other ones, and the optimum for each of them is achieved at various points. This fact introduces an uncertainty into the selection process. To solve these problems, it is necessary to use the relevant principles of multi-criteria optimization (*Ralph, L. Keeney, Howard Raiffa, 1981).*

There are also retrospective, current and future challenges (*Gupta, S., V. Krishnan, 2009*). The economy applies both formalized and expert methods of forecasting in their complex. We distinguish individual and collective expert methods. The extrapolation, correlation-regression, and adaptive methods belong to the formalized ones. Recently forecasting, based on neural networks and genetic algorithms, has received its significant development. The analysis of planned and forecast values allow, if necessary, to reach the adoption of specific management decisions.

We distinguish three types of tasks for comparative evaluation of options by the indicators plurality: the selection of a single object, forming a certain combination and the study of all the alternatives (*Lynn G.S., J.G. Morone, A.S. Paulson, 2009*)

Traditionally, the first type is considered to be the main, as the identification and application of advanced economic results is relevant at all stages of social development regardless of their form of ownership, and should cover all levels of the hierarchy in the economy. In multi-criteria formulation and in the presence of criteria contradictions the clear choice is rather hard (*Krishnan V., 2010*).

The ultimate goal of the second type problems consists in the formation of a set of objects. This situation occurs when you need to disperse the resource between several alternatives. As a rule, the limitation of the number of alternatives is contained in an implicit form, i.e. is expressed in terms of resources limiting, the financial for example.

Often there is a third statement - the analysis of all alternatives. It is coordinates with the national economic approach in economic studies. This type of tasks is characteristic of the cases when the alternatives have a common owner or a corporate management.

In case of the indicators combination application the unique solution shall be yielded by the principal of domination (*Ralph, L. Keeney, Howard Raiffa, 1981*).

This principal shall be formulated by following. In case the alternative S_1 out of two compared alternatives S_1 и S_2, is not worse by any of its indicators than the alternative S_2, and at least exceeds it by one of its indicators, than the alternative S_1 shall dominate over the alternative S_2.

Nevertheless, the principal is not always realized in practice. Otherwise the Pareto principal shall be applied *(*Ralph, L. Keeney, Howard Raiffa, 1981*).* In compliance with the latter multitude of effective alternatives which are not dominated by any other, is formed.

As applied to the problem in question the Pareto principal can be construed as follows. Alternatives $s_o \in S$ are called effective if there is not a single alternatives $s \in S$ so, that for all indicators at any *i the correlation* $K_i(s) \underline{\prec} K_i(s_o)$, $i = \overline{1,I}$, is fulfilled, and at least for one *i* the indicated preference shall be strict, that is $K_i(s) \prec K_i(s_o)$.

3. RESULTS

In case the aggregated indicators are applied, the principle of domination will give the unique solution. However, it is not always implemented in practice, and in this case the Pareto principle is used. According to the latter, a set of effective alternatives is formed not dominated by any other ones. The article offers the effective solutions determination technique for the analysis of multi-criteria problems. It consists in a stepwise selection of effective options possessing optimal values and formation of tolerance regions (Klychova G.S., Faskhutdinova M.S., Sadrieva E.R., 2015). The technique includes the following steps.

1. The initial set of comparable options (alternatives) is prescribed:

S = {Si}, i = 1, I. Sampled and calculated are the parameters K = {Kj}, $j = 1, J$ for each alternative. The preferred direction of change and the initial areas of permissible values are specified.

2. Determined are the effective options for each indicator in the first stage of analysis Sj_{opt1}. The index means the serial number of the analysis stage (iteration).

The alternative $S1_{opt1}$ having optimum value of the indicator *K*1 will be the first to be included into the effective solution. The second will be the alternative $S2_{opt1}$, characterized by an optimal value of the indicator *K2*, etc. The stage will be completed by the alternative SJ_{opt1}, having the optimum value indicator *KJ*. The cases of dominance are quite rare, especially when using many criteria, so usually additional analysis is required.

3. The range of permissible values of the indicators is formed in the first stage of PVA analysis. For this we pre-allocate the dominated areas with respect to all effective Sj_{optJ} options.

Then the range of permissible values of indicators is formed by the exclusion of the dominated areas from the original area.

4. Check of S_i options is conducted for their belonging to the tolerance region. Alternatives included in the resulting area, are subject to further analysis.

5. The Stages 2 – 4 actions are conducted. The only difference is that the optimal values of K_j are determined among the non-dominated alternatives obtained in the previous iteration. This stage is considered completed, when at a certain iteration $t = T$ less than two alternatives remain in the TR_T area.

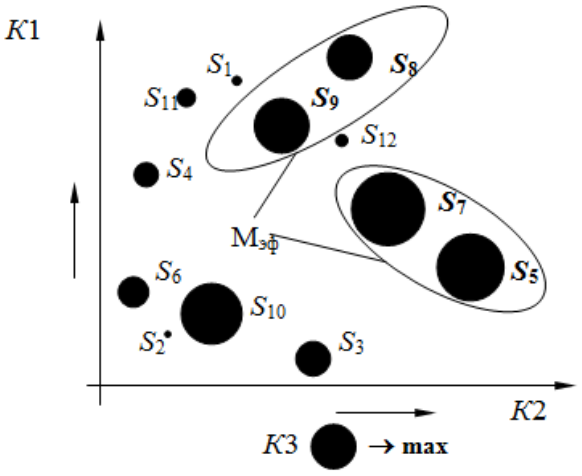
6. The effective solution is formed by uniting of effective alternatives identified at all stages of the analysis:

$$M_{ef} = \{S1_t, S2_t, \ldots, SJ_t\}, t = \overline{1,T}. \quad (1)$$

7. Check of effective options is conducted for compliance with the a priori requirements put forward by the party conducting the analysis. In case of identified differences, we adjust indicators and repeat the calculation.

Let us consider the example of the technique realization. The background information by the options S_1 – S_{12} is shown on the Figure 1. Hereinafter, the preferred directions of indicators change are shown by arrows. The value of the $K3$ indicator corresponds to the diameter of the circle.

Figure 1. Effective alternatives determination



The data is presented in the Table 1 for convenient analysis

Table 1. Analyzed options presented by the increase of the effectiveness

Indicators	*Compared alternatives*											
$K1$	S_2	S_3	S_{10}	S_6	S_5	S_7	S_1	S_{12}	S_9	S_{11}	S_4	S_8
$K2$	S_6	S_4	S_1	S_{11}	S_{10}	S_3	S_9	S_2	S_{12}	S_8	S_7	S_5
$K3$	S_2	S_3	S_{12}	S_{11}	S_1	S_6	S_5	S_8	S_9	S_{10}	S_7	S_4

We separate the effective options S_8, S_5 и S_7, having optimal values of indicators (in bold type) and form dominated areas. The first area includes options S_1 – S_4, S_6, S_{11} and S_{12}, the second and third areas– options S_2, S_3, S_6 and S_{10}. The range is concluded by an alternative S_9 (in bold type). Thus, the effective set will be as follows $M_{ef} = \{S_5, S_7, S_8, S_9\}$.

For the more detailed comparative evaluation of options we offer multi-criteria technique of preferred alternatives selection. The technique involves initial determination of pivotal options with optimal values of indicators, and the subsequent formation in their respect of the acceptable alternative sets, the transition to which is accompanied by improvement in other indicators. Then we get a joint solution by the partial sets intersection and isolate the only option by analogy with the previous stages (Kuznetsov V.P., Romanovskaya E.V., Vazyansky A.M., Klychova G.S., 2015).

The technique includes the following steps.

1. The initial set of comparable options (alternatives) is proscribed S = {Si}, i = 1, *I*. The indicators $K = \{Kj\}$, $j = 1, J$ for all alternatives are selected and calculated. The preferred direction of change and the initial tolerance regions are specified.

2. Pivotal alternatives are defined for each indicator. The first pivotal alternative shall be the variant having the optimum value of the indicator $K1$. The second pivotal alternative shall be the option characterized by an optimal value of the indicator $K2$, etc. The final pivotal alternative shall be an option having the optimal value of the indicator KJ.

3. With respect to each pivotal alternative we form a set of acceptable options M_j, the transition to which is accompanied by the improvement of other indicators. This set will be represented by the most pivotal alternative, in case this transition is impossible.

4. A joint decision M_Σ is determined by the intersection of acceptable sets M_j. The solution may contain one or several alternatives.

In some cases the acceptable sets are mutually disjoint, i.e. the criteria contradictions are essential. There should be applied the main indicator selection technique.

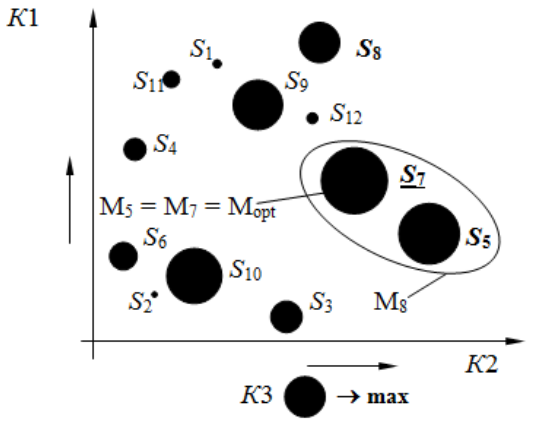
5. The final stage will need the selection of the only alternative to M_{opt} from the M_Σ under the paragraphs 2 - 4.

6. Check of the best alternative is conducted for compliance with the a priori requirements set forth by the party conducting the analysis. In case the differences are detected, the indicators adjustment is conducted and the calculation is repeated.

Here is an example of the technique implementation. The background information on the options S_1 - S_{12} is shown in Figure 2.

The data is presented in the Table 2 for convenient analysis

Figure 2. The best alternative determination



We separate the pivotal options S_8, S_5 и S_7 having optimal values of indicators (in bold type).

With the improvement of the second indicator we can move from the S_8 alternative on to the options S_5 and S_7, and with the improvement of the third - to S_5, S_2, S_9 and S_{10}. Then the set of the acceptable alternatives will be in the form $M_8 = \{S_5, S_7\}$.

With the improvement of the first indicator we can move from the S_5 alternative on to the options S_1, S_4, S_7 – S_9, S_{11} and S_{12}, and with the improvement of the third – to S_7. Then the set of the acceptable alternatives will be in the form $M_5 = \{S_7\}$.

With the improvement of the first indicator we can move from the S_7 alternative on to the options S_1, S_4, S_8, S_9, S_{11} and S_{12}. Thus, the set of the acceptable alternatives will be in the form $M_7 = \{S_7\}$.

We formulate the unique solution by way of the acceptable set intersection $M_{opt} = \{S_7\}$ (underlined).

Table 2. Analyzed options presented by the increase of the effectiveness

Indicators	*Compared alternatives*											
*K*1	S_2	S_3	S_{10}	S_6	S_5	S_7	S_4	S_{12}	S_8	S_{11}	S_1	S_9
*K*2	S_6	S_4	S_3	S_{11}	S_{10}	S_1	S_9	S_5	S_{12}	S_8	S_7	S_2
*K*3	S_2	S_1	S_{12}	S_{11}	S_4	S_8	S_2	S_8	S_9	S_{10}	S_5	S_7

4. CONCLUSIONS

Decision-making in the economy is a complex and multi-criteria task, which requires systematic accounting of factors combination for its successful research. In particular, the number of the contents of the analyzed alternatives and the used criteria is essential, as well as the interests of various parties, the number of hierarchical levels, need to forecast certain parameters, the requirements to the format of the final result and so forth.

If the ultimate goal is in shaping of certain set of options, then one should focus on the selection of the Pareto set technique. It consists in stepwise search of effective alternatives, characterized by optimal value of their indicators and building of tolerance range.

For determining of the best option, one may use the search of the preferred alternatives technique. The algorithm prescribes a preliminary determination of pivotal options and further elaboration of the acceptable alternatives sets in their respect, the transition to which is accompanied by the other indicators improvement. Then the general solution is elaborated by private sets intersecting and the unique option is received by the analogy with the previous stages.

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