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MULTI-CRITERIAN METHODS FOR SELECTION OF RATIONAL STRATEGIES OF DIVERSIFICATION OF BUILDING ENTERPRISES IN UNCERTAINTY

Abstract. *A thorough review and comparative analysis of well-known multi-criteria decision-making methods used for the task of ranking or selecting rational alternatives has been conducted in this article. It is revealed that most methods take into account the conditions of ambiguity of the environment. Since the problem of implementing diversification strategies is usually financially costly, it is proposed to use for selecting strategies for diversifying the activities of construction enterprises, a set of methods that focus on multicriteria decision-making under uncertainty. It is desirable to take into account the possible blurry of data, easy to implement and allow intuitively interpret the results (available scale of quantitative or qualitative assessments) without the constant involvement of experts or the decision maker.*

Keywords: construction enterprise; diversification; multicriteria methods of decision making

Introduction

The choice of business diversification strategies is a complex task, since as a rule, it is carried out on the basis of a whole list of criteria that have different degrees of importance, but their inclusion is obligatory when making a final decision. This decision clearly has a direct impact on the company's profit and determines its risks for the future, so the choice should be rational.

To select a rational diversification strategy, you can use methods of multi-criteria decision-making. In recent decades, these methods have become increasingly important due to their high relevance, new methods are being introduced, and already known and improved. In this section, the main known methods of multicriteria selection from a variety of alternatives are considered and their general assessment is made about the possibility of applying for the case of choosing strategies for diversification of construction enterprises.

The answer to the question of how to form an effective strategy and evaluate its effect from implementation can be the theory of adaptive strategic management [1]. In order to create effective diversification strategies, it is necessary to forecast the activity of the enterprise based on its performance indicators [2 – 7]. Also, strategic management of the company requires the application of new concepts of project and program management [8 – 13].

The purpose of the article

The aim of the study is to provide a review and analysis of multicriteria decision-making methods, in particular, the selection methods that could be used to select rational strategies for diversifying the activities of construction enterprises.

Review of multicriteria selection methods for the task of diversification of construction enterprises

The first group of methods presented in the review are methods based on the theory of fuzzy sets. Fuzzy set theory and fuzzy analysis are an effective tool for making multicriteria decisions [14]. The theory of fuzzy sets is a kind of extension of classical logic, which allows solving weakly structured problems that are associated with lack of information or the processing of inaccurate data. The peculiarity of applying methods using fuzzy logic to the multicriteria task of choice, which may be useful in solving the task of choosing strategies for diversification of construction enterprises, is the possibility of solving problems with great complexity based on just a few fuzzy rules. The disadvantage of using fuzzy methods for this task is the need for a large number of experiments before the appropriate methods can be used to select the real strategies of diversification.

Here is a brief overview of the recent years concerning the application of methods of fuzzy logic to the task of multi-choice choice. In [15] methods of ranking alternatives are investigated and a heuristic approach is proposed to determine the importance of criteria based on fuzzy logic and analysis of similarities. In [16], the decision-making process, in particular risk assessment, based on fuzzy procedures is considered. In [17], the task of managing orders is considered based on fuzzy methods for ranking these orders, which allowed them to be classified on an hourly basis. In [18] the method of ranking alternatives based on the economic effect of their implementation is considered.

A popular mathematical method for solving complex decision-making problems is the method of analyzing hierarchies [19, 20]. The main assumption of this method is the use of paired comparisons to evaluate alternatives according to different criteria. The undeniable advantage of the hierarchy analysis method is its simple application to a wide class of tasks, it is easy to scalable, and the benefits of experts are easily determined. However, the feature of the method is that it does not allow the object to be evaluated separately from others without identifying the advantages of the pair comparison method [21].

Stages of the hierarchy analysis method [22]:

1. Building a hierarchy that expresses the problem with alternatives, criteria and goals taken into account.

2. Applying the paired comparison method to prioritize all components of the hierarchy.

3. Generating common priorities for alternative options by constructing a convolution, usually linear, of the priorities of the components of the hierarchy.

4. Study of the received results on the adequacy and conformity of the set goal.

5. Decision making based on the received general priorities, taking into account all possible pair comparisons.

The application of the hierarchy analysis method is very extensive. In particular, in [23] the method of analysis of hierarchies for the study of urban water supply systems is used. In [24], an attempt was made to combine different approaches to multicriteria analysis to identify risks in assessing transport infrastructure. This method was necessary, because when applying only one of the methods of multicriterion analysis, the influence on the correctness of the decision has a significant influence on the choice of weight criteria of the criteria.

In the case of a combination of different methods, this effect is reduced. In [25], an attempt was made to construct a hybrid, multi-criteria decision making model combining the principles of the analytical network (ANP) and the methodology of laboratory research (DEMATEL). The application of this hybrid model concerns the trade sector. That is, in the last decade, scientists for the practical implementation of the method of analysis of hierarchies, combine it with other methods of multi-criteria decision-making. Moreover, this combination is expressed in built combined models, usually hybrid type, or less often, selective type.

An analytical network is an extension of thehierarchy analysis method and allows you to set advantages over clusters or groups of objects. Decision-making methods based on the analytical network can be used for planning tasks and especially for managing and selecting alternative projects according to a set of criteria.

The Multi-Attribute Utility Theory (MAUT) [26] has been used to assess risk and degree of uncertainty, as well as multi-criteria solutions [26]. This theory was one of the most frequently used for multicriteria tasks, in particular [27], based on it, the method of determination risks of land use. In [28], MAUT is used to determine the location of the organization of production. MAUT largely focuses on the management of natural resources in many studies, but can also be used for other risk assessment and multi-criteria decision making tasks. In particular, [29] analyzed the approach to using MAUT for multicriterion choice in order to avoid or reduce risk. The methods described in this article have allowed to identify weaknesses in the assessment of the risks of the whole industry, which respectively contributed to the correction of errors and more adequate calculation of the parameters of evaluation. Article [30] describes the use of MAUT for the task of providing emergency assistance in the event of evacuation and emergency situations. The article [31] describes a model based on MAUT that uses institutional, cultural, technical and other criteria designed to promote the stability and development of individual regions. Based on this model, the SANEX decision support system has been established, which has been successfully implemented in Indonesia. The use of MAUT for multicriteria assessment of climate change trends is described in [21]. The article [32] used a combination of methods of spatial analysis and multicriteria methods of analysis and decision making based on MAUT for assessing the risk of soil contamination in Europe.

The purpose of multi-criteria decision-making based on MAUT is the calculation of some function that determines the benefits of the person who decides on n criteria at each stage of the method. The main advantage of MAUT is the uncertainty in the data, but the disadvantage is the need to introduce at each stage a large amount of data that determines the benefits of the decision maker, which can greatly complicate the implementation of the method as a whole. In addition, the benefits should be introduced in the form of numerical coefficients, which subjectively affects the quality of the decision. Nevertheless, this method is used in agriculture, resource management, economic, financial and other issues that have a significant degree of uncertainty.

Another method that can be used in a multicriteria selection is the case-based reasoning (CBR) method. CBR is to solve new tasks based on already solved before. For example, if the task of adopting a multicriteria solution for the choice of a diversification strategy for a construction company has been considered earlier, then the scheme of building alternative strategies, a list of criteria and their evaluation can be identical, or at least very similar, that it is expedient to use for new tasks of evaluation of diversification strategies.

The CBR method in the general case consists of the following four main steps [33]:

1. The allocation of memory cases that are directly related to the task and may be useful for its solution.

These cases should consist of a goal, a solution, an annotation or a justification of how the solution was obtained.

2. Adaptation of the selected case to the set task, taking into account the goal, alternatives and criteria.

3. Simulation or check whether the resulting solution can be applied to a new task.

4. Save the obtained solution in the basis of cases if the adaptation was successful.

Let's consider some successful examples of implementation of CBR-based methods. The article [34] describes a new forecasting method for CBR-based financial instruments. The information for the verification was compiled on the basis of auction results on the Shenzhen Stock Exchange in China. CBR was used to predict the similarity based on the distance of Euclid and the urban metric. The ROCBR (ranking-order case-based reasoning) method is constructed, which allows us to find similarities between fragments of information that is selected from the current task and information that has been identified in the past. In [35], the modified CBR method is considered for the task of transport insurance. Such a task has a large database of cases, so it is rational to solve it based on the CBR method. The advantages of the method is that, with the increase of the base case, the accuracy of the solution will be improved. In addition, there is no significant cost of constructing and maintaining a database. The answer from such a database adapts over time, which is a natural reaction to changing environmental conditions. However, the significant disadvantage of the method is its sensitivity to inconsistency of data, so the necessary condition for the application of the CBR method is a significant amount of previous cases, which are described in detail in the database. It is precisely because of this most applied research using this method relates primarily to the sphere of insurance, the evaluation of the outcome from the treatment of drugs. Also, this method is widely used to compare enterprises, in particular to compare their strategies, which might be useful in conducting a diversification strategy assessment study.

Another methodology that has a direct close relationship with multi-criteria optimization and system analysis is Data Envelopment Analysis (DEA). This methodology allows for a thorough comparative evaluation of the functioning of complex technical, social and economic systems and is based on linear programming [36, 37]. Using linear programming DEA allows you to measure the relative efficiency of alternatives, which are then ranked in order of decreasing efficiency. The alternative that is most effective is rating 1, and all other alternatives that are compared with this one receive an estimate of less than 1. Moreover, the closer the score to 1, the more rational choice is the alternative. This information is provided to the person who makes the decision. Of course, the evaluation can be both quantitative and qualitative.

The disadvantage of the DEA method is that its application may not contain inaccurate data, or data with incomplete information. That is, the application of this method in conditions of uncertainty is complicated. However, the method works well in the case where the effectiveness of alternatives must be compared with each other. Therefore, the application of this method can successfully solve the problems of agriculture, trade, medical industry, business, etc.

The article [38] considers the linear programming problem for the calculation of efficiency for a decision-making unit based on DEA. The verification of this study was conducted to evaluate the performance of companies specializing in the production of liquid crystal displays in Taiwan. Also, the DEA methodology has been successfully used for agricultural purposes in India [39]. The authors have been able to rank farmers from the most effective to the least effective ones in order to identify the weaknesses in the agricultural sector of the region. A similar concept can be successful in case of ranking of diversification strategies of construction companies. In [40], the use of the DEA method for assessing the effectiveness of training in 30 universities was proposed. In general, the method proposed in this paper made it possible to rank the efficiency of selected universities in order of decreasing efficiency. There are also successful results of using this method for multicriteria investment decisions, in particular for large industrial companies and holdings [20].

Let's consider some more methods of multi-criteria decision making, which proved to be effective. The article [41] describes the method of SAW (simple additive weighting) or the method of ordinary weighting. The method is based on adding goals for each criterion to each goal, taking into account the weight of these criteria. The advantage is a very simple calculation, which may not need hardware, so often this method is used in business, the financial sector for quick calculations when establishing a rational alternative.

For the analysis of multicriteria solutions, the ELECTRE method (ELimination and Choice Expressing REality) is also used. The classic ELECTRE method consists of two main steps:

1. Establishing the ratio of benefits between each pair of alternatives according to different criteria.

2. Procedure for forming recommendations and conclusions based on the results of the first stage. This stage depends on the objectives of the task, in particular, that I want to see the person who makes the decision: ranking alternatives, choosing, etc.

The ELECTRE method may require the use of concordance analysis, since the benefits of the various experts may vary. The advantage of the method is the possibility of its use in the case of uncertainty, and it can be applied in combination with fuzzy methods that provide blurriness of data and qualitative evaluation of alternatives.

It is these advantages that are important for many economic, environmental, energy and other tasks [20; 42].

Another method of multi-criteria analysis is the SMART method. The method is a simplified form of MAUT. It is believed that the method quite successfully cope with the conversion of importance weights to numerical estimates. The method is easy to use, does not require constant involvement of decision makers at all stages of the calculation. However, the necessary condition for its use is the availability of information about alternatives and the availability of an expert environment. There are described results of using the SMART method in construction, logistics, transport management, manufacturing, etc. [21].

The PROMETHEE family of methods is similar to the content of the ELECTRE methods, because they use the ratio of even advantages between alternatives. The method is easy to use, but there are difficulties in assigning weights, which does not negate its effective use in agriculture, business, chemical production, etc. [20].

Conclusions and recommendations for further research

According to the results of the analysis of known methods for making multicriteria decisions and multicriteria analysis, it can be concluded that the vast majority of methods take into account, to varying degrees, the conditions of uncertainty, but their use in isolation may complicate the interpretation of results. Since the research problem has a problem that in the event of an incorrect solution can lead to significant financial losses, it is proposed to use alternatives that reflect the strategies of diversifying the activities of construction enterprises, several methods that focus on decision making under uncertainty, it is desirable to take into account the blurring of data , relatively easy to implement and allow to intuitively interpret the results (existing scales of quantitative or qualitative estimates) without the constant involvement of experts or the person who makes the decision. Also important task of the constructed method should be a clear understanding of the advantages of some alternatives over others, which allows, if necessary, to adjust the final solution. Therefore, in general, a new or combined method constructed taking into account the results of other methods should be focused not only on choosing one alternative from the set of permissible alternatives, but to form their ranked list. This list is for consideration by the expert environment and the person who makes the decision to determine a rational strategy for diversifying the activities of the enterprise.

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БАГАТОКРИТЕРІАЛЬНІ МЕТОДИ ВИБОРУ РАЦІОНАЛЬНИХ СТРАТЕГІЙ ДИВЕРСИФІКАЦІЇ БУДІВЕЛЬНИХ ПІДПРИЄМСТВ В УМОВАХ НЕВИЗНАЧЕНОСТІ

Анотація. *Проведено ґрунтовний огляд та порівняльний аналіз відомих багатокритеріальних методів прийняття рішень, які використовуються для задачі ранжування або відбору раціональних альтернатив. Виявлено, що більшість методів враховує умови невизначеності зовнішнього середовища. Оскільки проблема впровадження стратегій диверсифікації, як правило, фінансово затратна, пропонується використовувати для відбору стратегій диверсифікації діяльності будівельних підприємств комплекс методів, які зосереджені на багатокритеріальне прийняття рішень в умовах невизначеності, а також враховують можливу розмитість даних, нескладно реалізуються та дозволяють інтуїтивно інтерпретувати результати (наявні шкали кількісних або якісних оцінок) без постійного залучення експертів або особи, яка приймає рішення.*

Ключові слова: будівельне підприємство; диверсифікація; багатокритеріальні методи прийняття рішень

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