Application of the Method of Hierarchy Analysis for Decision Making in Conditions of Definition

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Abstract. Person makes decisions based on known information and using a certain method every day. The hierarchy analysis method is viewed as the general theory of measurement; it is used to derive the ratio scales from both discrete and continuous pair comparisons in multilevel hierarchical structures. Comparisons can be made on the basis of real or alleged values reflecting possible preferences. The method is widely used in problems of multi-criteria decision making, strategic planning, forecasting, and even in conflict resolution problems. Moreover, it is intended for the analysis of nonlinear structures to perform both deductive and inductive inferences.

Keywords: Risks, analysis, decision making, hierarchy, criterias.

1   Introduction

Our entire lives are made up of decision-making processes, in which we strive to achieve some goal in the best way for us.

People pay for all their personal decisions - spend money by buying unnecessary things, working in "wrong" places. But business decisions made by heads of enterprises, regions, all over the country affect the fate of many people and entire nations. That is why such high demands of society for the quality of decision-making are becoming more and more complex in today's world. Problem solving is complicated not only by their interrelation and the growing number of influencing factors, but also by the presence of a large number of possible options for their adoption.

Awareness of the potential risk of decision-making motivates people throughout human history to seek the opportunity to calculate which of the possible decisions is most favorable to the decision-maker or to the human community.

In the twentieth century, decision-making science reached its prime and used the great theory and practical methods used by the decision-maker in its activities. The reasons for this heyday are:

  - Rapid population growth.

- The rapid development of scientific and technological progress, in particular military weapons.
- Global military conflicts caused by causes 1 and 2.
- Awareness of humanity that the level of military technology has reached the possibility of destroying all humanity by humanity itself.

2   Formulation of the Problem

The problem of choosing a method for decision-making is extremely important, as it can affect not only the decision-maker but also other people. Therefore, you need to choose a method that will be perfect for decision making under certainty.

3   Analysis of Recent Research and Publications

In the early 1970s, American mathematician Thomas Saati developed a decision support procedure, which he called the Analytic Hierarchy Decision Process. In Ukrainian translation, this name sounds like the "Method of Hierarchies Analysis" (MHA).

Initially, the hierarchy analysis method was intended to address the problem of arms selection. In the future, it has become more widely used as a method of integrated decision making.

In general, the hierarchy method is based on pair comparisons between alternatives and criterias. The alternatives to the different choices you need are what from you choose. For example, when choosing a new cell phone, the alternatives - its models of this phone. The criteria are different alternatives that are important for choosing properties of (characteristics) alternatives. In the same example of choosing a cell phone, the criteria may be the size of the phone, its weight, color, the presence of various additional features.

In the first stage of the method, it is necessary to decide on two lists. In the first list (the list of alternatives), there will be between things that we make the choice. In the second list (criteria list), it will be on what grounds we make our choice.

The next step in the method of hierarchy analysis is to determine the degree of importance of the criteria. In comparison, some criteria may be more important than others and the task of the method is to determine the degree of importance of each criterion. For cell phones, such thing as having an mp3 player, it can be much more important than color. And it can be the other way around, because everything depends on the person making the choice. To determine the degree of importance, make a pair comparison of all the criteria on a scale of 1 to 9 (conditional scale, you can choose any other). When comparing two criteria A and B, which answers the question "What is more important than A or B, and how much?" a value of 1 means that B is much more important than A. The value of 9, by contrast, is that A is much more important than B. The value of 5 is to determine that A and B are equally important.

In the next step of the method, pair comparisons of all alternatives are made for each of the criteria. All the same scale from 1 to 9 is used for comparisons. An example of a question at this stage is: "How much is phone A better (worse) than phone B in color criteria?". After receiving all the answers, the answer data is processed and all the alternatives are quantified, that is, what is the alternative in the first place, which is in the second and so on.

At the last stage, based on a hierarchy of alternatives, one makes his conscious choice.

4   Formulating the Purpose of the Article

In this article, we will consider the method of hierarchy analysis as a method that is ideally suited for decision making under certainty. Consider the essence of the method, analyze its effectiveness and familiarize with all the stages.

5   Presenting Main Material

A hierarchy arises when systems that function at one level function as parts of a higher-level system, becoming subsystems of that system. MHA is a procedure for hierarchical representation of the elements that determine the essence of the problem. The method is to decompose the problem into simpler components of further processing the sequence of judgments of the person, who makes the decision by pair comparisons. However, the MHA involves the process of synthesizing many judgments, prioritizing criterias, and finding alternative solutions.

It does not solve for the person, who make decision, the only correct answer, but simply offered the possibility to choose from suggested options the option that best suited his problems.

The Saati method is so popular because it can be applied to any area where you may have a problem that needs a thoughtful solution. It is used to make decisions at the interstate level, in education, in business, to solve personal problems. The application of the method begins at the stage of building a hierarchy (a certain structure), which contains images of the goal, criteria and alternatives, it is also possible to depict other factors that may influence the decision, if any. This structure is needed to represent the problem through the eyes of the decision-maker. Each of the separation elements presents different aspects of solving the problem, it can be both tangible and intangible factors that measure the parameters, characteristics, data and expert judgment. After the first stage, there is a second stage, which prioritizes the important ones or gives preference to certain elements of the hierarchical structure using paired comparisons. Dimensioned priorities are great for making good comparisons of different factors. In the third and final stage, priorities are divided into specific hierarchies, which will further allow to consider for alternatives concerning

to the primary objective. The best alternative is the one that has the highest priority value.

If you consider all the steps that are used in the MHA, you can distinguish the following:

1) Outline the problem and identify a common goal.
2) Build a hierarchy starting from the top: purpose, criteria, list of alternatives.
3) Build a rating scale for each criterion, defining the range of possible changes.
4) Construct multiple matrices of paired comparisons for each of the lower levels by the principle: one matrix for each element is adjacent to the top of the level. This item is called a managed item with respect to the item at the lower level. Elements of any level are compared to each other for their effects on the controls.
5) Matrixes of even comparisons are constructed taking into account the quality of the inverse symmetry, ie Aij * aji = 1, aji = 1, which guarantees the consistency of matrices of even comparisons (the consistency of the matrix in terms of mathematics is a linear dependence of all rows and all columns of the matrix. For an agreed matrix of pair comparisons, the production of all its elements is exactly 1.
6) Steps 3, 4, 5 must be performed for all levels and groups of the hierarchy. The paired comparison matrices thus constructed are the initial data for further calculations (essentially, from the information presented in the analog form, the records have been converted to numeric). Next, you must decide on the analysis tool: choose a linear or nonlinear method of analysis of hierarchies.
7) For each matrix of pair comparisons, a vector convolution obtained by the normalization of the specified matrix is calculated. The sum of the elements of the vector convolution is equal to 1 for the linear (nonlinear) method. For linear MHA, the elements of the convolution vector are obtained by dividing each element of the column of the matrix of paired comparisons by the sum of the elements of that column. For nonlinear MAI, the elements of the convolution vector are obtained by calculating the geometric mean of the row elements of the matrix of pair comparisons.
8) Next, it is necessary to calculate the vectors of local priorities as a result of multiplying the matrices of pair comparisons by their corresponding vector-convolution.
9) At each level of hierarchies of vectors of local priorities, a reduced matrix is constructed, which is multiplied by the vector of the local priority of the higher level. The result is a final vector of global priorities.

6 Conclusions

Analyzing the Saati method, we can say that it is rapidly developing and widely used by scientists with a worldwide name. This distinguished scientist described this method in several books that are popular today, develops software applications, and

has been successfully hosting symposia for twenty years. The Saati method combines not only mathematical but also psychological aspects. It enables the decision-maker to portray their problem as a hierarchy, which in turn will make it easier to compare and evaluate possible solutions to the problem.

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168

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