

The Application of the Analytic Hierarchy Process for Multicriterion Evaluation of the Enterprise's Investment Attractiveness

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Abstract

The multicriterion evaluation of enterprise's investment attractiveness by using the analytic hierarchy process (AHP) is discussed in this paper. The AHP is a multi-objective, multicriterion decision-making approach that employs a pairwise comparison procedure to arrive at a scale of preferences among a set of alternatives. The main stages of implementation of the AHP are considered. For the evaluation of investment attractiveness authors defined the most significant groups of factors and factors of investment attractiveness. Using the matrix of pairwise comparisons as a tool to assess the significance of the parameters of the investment attractiveness and a hierarchy of complex index of investment attractiveness ensured the creation of a new algorithm for evaluation the investment attractiveness.

Index Terms: Investment attractiveness, Analytic hierarchy process (AHP), Enterprise.

I. INTRODUCTION

In the modern conditions the attracting investment become an integral reality of the operation of enterprises, in which are interested both well-developed and developing company.

The attraction of investments is more important for the developing enterprises as far as their inflow promotes enterprise development, application of new technologies, upgrading of worn fixed assets and other important objects promoting the development of the enterprise.

Russian and foreign authors were studying issues of investment attractiveness but there is no single approach to the definition of the term in economic literature, because of its many aspects. According to L.S. Valinurova and O.V. Kazakova, this term refers to set of objective features, properties, facilities and opportunities that determine potential effective demand for investment [1].

There are other points of view, according to which the meaning of investment attractiveness is understood as an assessment of efficiency of use of own and extra capital, the solvency and liquidity analysis (similar definition – structure of own and extra capital and its placement between different types of property and also efficiency of their use) [2].

From our point of view, the investment attractiveness – is the set of investment attractive factors of the investment object of investment, the based on analytical and forecasting data which reflect the level of risk and profitability to carrying out investments.

The analytic hierarchy process (AHP), initiated by Thomas Saaty [3, 4] was chosen for the evaluation of the enterprise's investment attractiveness. This tool was first developed by Saaty in 1980, and later improved upon in subsequent years (Saaty, 1980, 1994, 2000, and 2001) [4]. It's different to other methods by its system wide approach, the possibility of using quantitative and qualitative criteria, by its demonstrativeness and apprehensibility and wide popularity. Successful AHP applications have been reported in marketing, finance, education, public policy, economics, medicine and sports [3, 4, 5].

II. MAIN PART

During the study, with the help of experts identified the following evaluation factors of enterprises investment attractiveness such as financial, human resources, innovation and territorial factors were defined [6].

As the financial factors of evaluation of investment attractiveness of enterprises were defined the following: index return on investment (ROI), payback period (PP), dividend yield (DP).

As human resource factors of evaluation of investment attractiveness of enterprises were selected: the following: number of highly qualified staff (FAC), Staffing (S), labor productivity (LP).

As innovation factors of evaluation of investment attractiveness were chosen the following: the number of implemented technologies (NIT), frequency of implementation staff development courses (FDC), the quality of products or services (QS).

As territorial factors of evaluation of investment attractiveness of enterprises were selected: proximity to the necessary objects (P) and an ecological situation in the location (ES).

The system of indicators selected for the evaluation of investment attractiveness and compiled data on the companies at the current time of the analysis are presented in the Table I. Prior to the assessment for analyzing hierarchy experts gave estimates for the compared alternatives enterprises. Firstly, experts identified the best and worst alternatives; there are enterprises 4 and 5, consequently. The experts pointed to the prevalence of high and very high (for the company 4) and low and very low (for the company 5) indicator scores. For the other enterprises there was established the following order towards to decreasing priority: 4, 3, 1.

For the evaluation of enterprises investment attractiveness was selected analytic hierarchy process (AHP) proposed by Thomas Saaty [3, 4]. Unlike the other methods it has system-wide approach, the opportunity of using quantitative and qualitative criteria, visibility and accessibility of perception and big prevalence.

The process of applying the AHP method includes several steps. The list and the order of those steps are shown in Fig. 1 [3, 4].

We return our more detailed attention to the stages of the AHP.

Making the decisions is breaking down into components which are presented in the form of hierarchy of objectives (Fig. 2).

The weight indexes express relative importance of each criteria are evaluated. For this purpose the pairwise comparison of chosen criteria is used. Due to the fact that in the hierarchy are use both quantitative and qualitative evaluation criteria, which make the usage of mathematical models more complicated, is usually resort to the experts evaluations which defines the importance of the criterion to the enterprise based on

TABLE I
THE INDICATORS SELECTED FOR THE EVALUATION OF INVESTMENT ATTRACTIVENESS AND THEIR VALUES ON THE COMPARING OBJECTS

Name	The compared enterprise's				
	1	2	3	4	5
<i>Financial factors</i>					
I1 – The index return on investments	1,24	1,18	1,32	1,44	1,05
I2 – The payback period, month	27,5	25	19	18,5	20
I3 - Dividend yield, %	1,4	1,6	2,8	3,6	2,9
<i>Human factors</i>					
I4 - The number of highly qualified staff	105	110	120	140	60
I5 - Staffing	Average	low	High	High	Low
I6 - Labor productivity	Average	Average	High	High	Low
<i>Innovation factors</i>					
I7 - The number of implemented technologies	10	22	16	13	6
I8 - Frequency of staff development courses	Average	Average	High	High	Low
I9 – The Quality of product or service	Average	High	Average	High	Average
<i>Territorial factors</i>					
I10 - Proximity to the necessary object	Near	Far	Far	Near	Far
I11 - Ecological situation in the location	Bad	Good	Good	Good	Bad

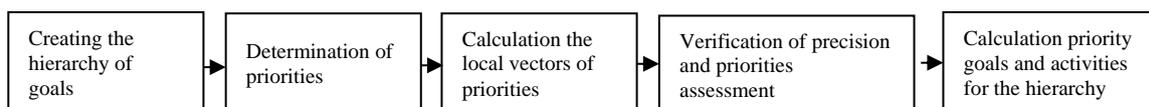


Fig. 1. The main stages of the AHP method

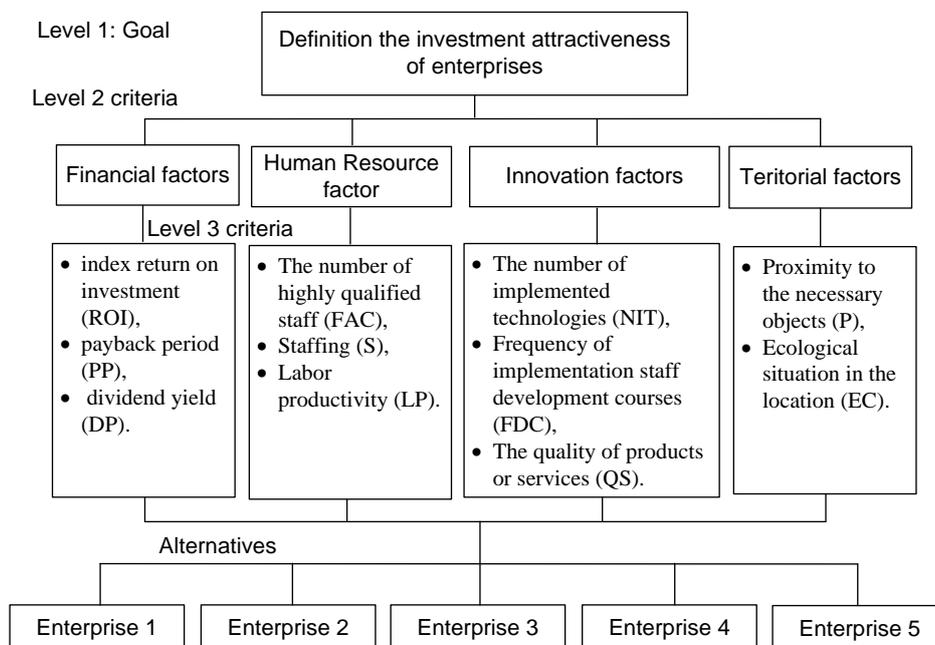


Fig. 2. Hierarchy for determining the investment attractiveness of enterprise

TABLE II
SCALE OF PREFERENCES

Degree of preference	Scoring
The lack of preference	1
Weak preference	3
Moderate preference	5
Strong preference	7
Absolute preference	9
Intermediate grades	2,4,6,8

experience which do not draw to formalization, intuition and knowledge. For comparison can be used 10-point scale of preferences (Table II).

Note: If the assessment of an indicator of i is expressed by numerical value X relatively indicator j , an assessment of an indicator of j the return in relation to i indicator value ($1/X$).

The results of comparison are summarized in the table – the matrix of pairwise comparisons (Table 3). While comparing the criteria often wonder what the criteria is more important, but while comparing the alternatives to criteria are wondered which of the alternatives is preferable, or more expectable?

Since human experience can't be expressed by exact formula the comparison of multiple objects transitive (sequential) and cardinal (quantitative) consistency can be violated. The consistency index (CI) or the consistency ration (CR) are used in the paired comparison method or the dependence of consistency, which express by the following statement:

$$CI = \frac{\lambda_{max} - n}{n - 1}; CR = \frac{CI}{M(CI)}; \tag{1}$$

where n - the order of matrix A ; λ_{max} - the maximum eigenvalue of A , $M(CI)$ – expectation value CI randomly drawn matrix of pairwise comparisons A . The criterion for testing the consistency of judgments should be $CR \leq 0,10$ [4, 5].

TABLE III
MATRIX OF PAIRWISE COMPARISONS

Factor	1	2	3	4	w
1. Financial factors	1	5	3	7	0,563
2. Human factors	1/5	1	1/3	3	0,117
3. Innovation factors	1/3	3	1	5	0,263
4. Territorial factors	1/7	1/3	1/5	1	0,055
$\gamma_{max}=4.12; CI=0,039; CR=0.04$					

Mathematical treatment of the matrix of pairwise comparisons was limited to the determination of its right eigenvector (w), consistency index (CI) and consistency ratio (CR).

While filling in the matrix of pairwise comparisons of criteria groups towards to an aim of hierarchy experts answer the following question: «Which group of factors plays an important role in the total investment attractiveness of the enterprise?». While determination the weight index of particular criterion experts answered the question: «Which of the individual criteria is of great importance in this group of criteria?». When filling in the matrix of pairwise alternatives experts should answer the questions: «Which enterprises 2 or 4 has larger dividend yield?» Etc.

After filling out the 15 matrix of pairwise comparisons the calculation priority of alternatives were performed concerning all criteria including into the hierarchy of AHP [3, 4]. The resulting vector of priority of alternatives regarding to the purpose have the following form: {0.104 0.103 0.186 0.220 0.087} (Fig. 3).

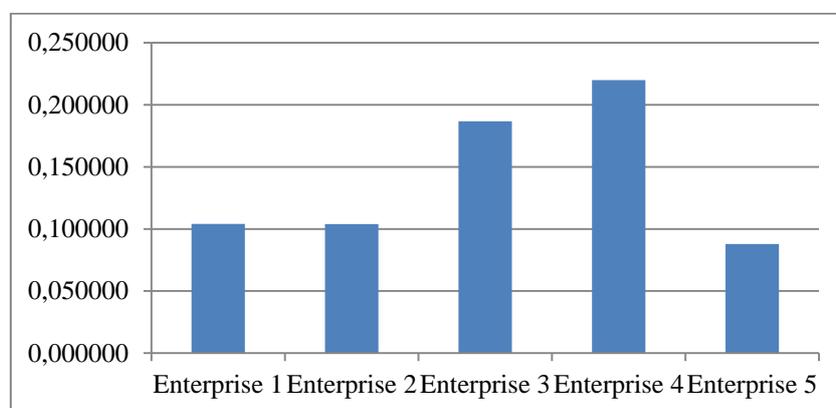


Fig. 3. The priorities of alternatives received with the help of using the AHP

From the received vector of priorities it is possible to draw the following conclusions. The analyzed enterprise 5 is positioned closer to group of outsiders. By the majority of the most important indicators it loses or it is comparable to the alternatives 1, 2, 3. The obvious leader is the enterprise 4. Its characteristics can serve as reference points while developing the program of increasing the investment appeal of the enterprise 5.

III. CONCLUSION

The received results can be interpreted as following:

1. The system approach which allows making the evaluation of investment attractiveness of enterprises based on an expert method of the analytic hierarchy process was proposed. To solve this problem the indicators of investment attractiveness were proposed.

2. The quality of received results (such as adequacy, accuracy, consistency, objectivity) at the usage of AHP in many respects is defined by entirety and reliability of the initial information and also by skill level of expert's skills.

3. The analytic hierarchy process is a unique method in the theory of multicriterion decision-making, allowing to formalize and structure complex problem, for which quality modeling is required to consider big enough (some tens) the number of indicators.

4. Computer support of the offered approach allows making numerous computing experiments with the analysis of complex problems of estimating the investment attractiveness of enterprises that allows to study a problem comprehensively, to raise the objectivity and quality of accepted management decisions.

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