The Application of the Analytic Network Process in Evaluating Assets Management of the Institution of Higher Education

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Abstract

The Analytic Network Process is a decision method developing on the basis of AHP. This article introduced the basic theory of ANP and discussed its application in evaluating assets management of the institution of higher education through establishing evaluation index system and confirming the weight of every index.

Keywords: The Analytic Network Process, Assets management of the institution of higher education, Evaluation Index System

1. Introduction

After the accumulation and development of a long time, Our institutions of higher education has developed considerable quantity of state-owned assets, which provide effective physical protection for finishing the task of teaching and research, production, administration and logistics service. At present, due to the scale expansion, most institutions' of higher education capital and financial situation is not optimistic. It is a practical and pressing problem to ensure the health development of institutions of higher education using the limited funds. School property is the common property of the country and the people, and is the important security for school to engaging teaching and scientific research. To improve the efficiency and quality of instruction and promote the sustainable development of school, we must accomplish the management work of the state-owned property. Therefore, it becomes more and more important to evaluate the level of assets management in institution of higher education. This text established the index system of evaluating assets management of institutions of higher education and then evaluate the management level of assets management in institution of higher education through ANP in order to promote institutions of higher education to aware of its own level of assets management and to take further measures to improve their level of assets management and then promote their sustainable development.

2. The theoretical introduction of ANP

The Analytic Network Process is a new and practical decision method developing on the basis of AHP. It is eliminated by Professor T.L. Saaty. It is a decision method which adapts the independent class structure. It takes feedback and dependent among levels and internal elements into account on the basis of AHP, researches deeply on the sorting methods of the super-matrix and the margin of the super-matrix methods of the feedback system, and determines the weight coefficients of indexes.

The difference between ANP and AHP lies in that the model established by ANP is network process structure while the model established by AHP is hierarchical structure. In a network process structure, each node denotes an element or an assembly of element, and each element or each assembly of elements in the system may affect each other. This enables the calculation procedures of ANP be more complicated. In addition, the policy principles of both methods are basically the same. Both need firstly establishing a structural model on the basis of detailed analysis on the question, secondly building a matrix of judge of each two indexes, thirdly calculating the relative weight.

3. Evaluation Index System of Assets management in institutions of higher education

It is necessary to establish the evaluation index system of Assets management in institutions of higher education in order to evaluate the level of assets management in institution of higher education with ANP. This text evaluates the level of assets management in institution of higher education in such three aspects as input of assets management, efficiency of assets management and output of assets management.

3.1 Input of assets management

There are many indexes that influence the input of assets management in institutions of higher education, in which we select three factors as personnel, capital and equipment.

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3.2 Efficiency of assets management

The efficiency of assets management, which is in relation to the transformation of the input of assets management to the output of assets management, is essential to assets management in institutions of higher education and is usually analyzed in four aspects such as the purchase of assets, the use of assets, the maintenance of assets and the disposal of assets.

3.3 Output of assets management

In order to increase the economic and social benefit of asset management in institutions of higher education, the purpose of the input of assets management in institutions of higher education is to have the corresponding output. Asset management output is usually analyzed from three aspects such as students intake and employment opportunities among graduates, that is, talent training, teaching and research results of teachers, and economic performance of the industry.

Specifically, the evaluation index system of assets management in institutions of higher education is established as that in table 1.

4. Evaluation of the level of assets management in institutions of higher education based on ANP

4.1 Building the network process structure model

According to the above evaluation Index System of assets management in institutions of higher education, this text sets up the network process structure model as that in figure 1 which looks on the level of the asset management in institutions of higher education as control layer and the rest indexes as network layer.

4.2 Building a matrix of judge of each two indexes

Every factor in each layer which is related with a certain factor in the higher layer is compared with each other according to the importance, or the usefulness of a certain index in each scheme layer is compared, and then a matrix of judge of each two indexes is formed(as in table 2). If there are n indexes that are in for comparison, then A= $(a_{ij})_{n\times n}$, in this equation, a_{ij} denotes the important point of A_i and A_j are compared with each other based on the rule of B_i.

At the norm of the asset management level of institutions of higher education, the input of assets management is compared with efficiency of assets management and output of assets management, and then a matrix of judge of each two indexes is shown in table 3. The data in table 3 are formed through the questionnaire survey to expert, which reflect their opinion on the relative importance of the elements; The relative weight is calculated by the software of matlab and normalized.

4.3 Building the ultra matrix and the weighted ultra matrix of ANP structure

Besides the control layer, there are three elements set in the network layer including the set of asset management input, asset management efficiency and asset management output. A matrix of judge of each two indexes is built respectively at the norm of the level of assets management in institutions of higher education and the secondary norm of the elements in the elements set. For example, at the norm of personnel, a matrix of judge of each two indexes in the set of efficiency of assets management is shown in table 4. The relative weights form the subset of the ultra matrix

The ultimate weight between the interaction factors is calculated with the ultra matrix in ANP. The ultra matrix is a separate matrix. The data in table 5 form the ultra matrix which is made of 20 eigenvector of the interacting elements which is compared with each other.

The middle 4 data in the first column of table 5 are from the weight between each elements calculated in table 4(in the last column in table 4). We can build such ultra matrix as table 5. This matrix is not a normalization matrix. Therefore, at the norm of assets management level in institutions of higher education, the importance of each group of elements to the rule is compared with each other. The weight of each group of elements is supposed to be 0.3333, so we can get the following ultra matrix as in table 6. This matrix is a random matrix.

The weighted ultra matrix is evolved 2k+1 times, k approaches to the infinite, and the results achieved. Then a long-term stability matrix is formed. The nonzero value in every row of the ultra matrix is equal. Then the value of the corresponding array of the original matrix is the stability weight of every evaluation index to the object, which is shown in the margin ultra matrix in table 7.

It can be seen from the data in table 7 that talent training is mast important to the level of assets management in

institutions of higher education, then capital input, the use of assets, the maintenance of assets, personnel input, teaching and research results, the disposal of assets, equipment input, economic performance of the industry and the purchase of assets. Each institution of higher education should take main measures to improve the level of assets management in institutions of higher education to further enhance the usage efficiency of assets on the basis of its practical factors and the degree of each factor influencing the level of assets management in institutions of high education.

5. Conclusion

Evaluating the level of assets management in institutions of higher education with ANP can embody accurately and completely the related degree between each index. The degree of each index's influence on the level of assets management in institutions of higher education can be confirmed by the weight and then the main factor can be found to provide according basis to improve the level of assets management in institutions of higher education. At the same time, the implication of the software of Matlab makes it operable to evaluate the level of assets management in institutions of higher education with ANP.

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Table 1. Evaluation Index System of assets management in institutions of higher education

The level of assets management in institutions of higher education A	Input of assets management B_1	Personnel C_1
		Capital C_2
		Equipment C_3
	Efficiency of assets management B_2	The purchase of assets C_4
		The use of assets C_5
		The maintenance of assets C_6
		The disposal of assets C_7
	Output of assets management B_3	Talent training C_8
		Teaching and research results of teachers C_9
		Economic performance of the industry C_{10}

Table 2. Meanings of a_{ij}

a_{ij}	Meanings of a_{ij} （based on the rule of B_i）
1	A_i equals A_j
3	A_i is moderate important than A_j
5	A_i is more clearly important than A_j
7	A_i is clearly important than A_j
9	A_i is absolutely important than A_j
Note：2、4、6、8 is the median of the adjacent judge, $a_{ij}=1/a_{ji}$, $a_{ii}=1$	

Table 3. A-B matrix of judge

A	B_1	B_2	B_3	ω	The value of index through consistency testing
B_1	1	1/3	1/5	0.1047	λ_{max}=3.0385
B_2	3	1	1/3	0.2583	C.I.＝0.0193
B_3	5	3	1	0.6370	R.I.=0.52
					C.R.=0.0371

Table 4. A matrix of judge of each two indexes in the set of assets management efficiency at the norm of personnel

Personnel C_1	The purchase of assets C_4	The use of assets C_5	The maintenance of assets C_6	The disposal of assets C_7	Relative weight
The purchase of assets C_4	1	1/5	1/4	1/3	0.0684
The use of assets C_5	5	1	3	4	0.5292
The maintenance of assets C_6	4	1/3	1	3	0.2681
The disposal of assets C_7	3	1/4	1/3	1	0.1342

Table 5. The ultra matrix between elements at the norm of assets management level in institutions of higher education

	Personnel C_1	Capital C_2	Equipment C_3	The purchase of assets C_4	The use of assets C_5	The maintenance of assets C_6	The disposal of assets C_7	Talent training C_8	Teaching and research results C_9	Economic performance of the industry C_{10}
Personnel C_1	0.2583	0.2583	0.2684	0.2684	0.2185	0.2185	0.2364	0.2364	0.2290	0.2290
Capital C_2	0.6370	0.6370	0.6144	0.6144	0.7147	0.7147	0.6817	0.6817	0.6955	0.6955
Equipment C_3	0.1047	0.1047	0.1172	0.1172	0.0668	0.0668	0.0819	0.0819	0.0755	0.0755
The purchase of assets C_4	0.0684	0.0684	0.0954	0.0954	0.0684	0.0684	0.0636	0.0636	0.0490	0.0490
The use of assets C_5	0.5292	0.5292	0.4673	0.4673	0.5292	0.5292	0.5408	0.5408	0.5824	0.5824
The maintenance of assets C_6	0.2681	0.2681	0.2772	0.2772	0.2681	0.2681	0.2639	0.2639	0.2550	0.2550
The disposal of assets C_7	0.1342	0.1342	0.1601	0.1601	0.1342	0.1342	0.1317	0.1317	0.1136	0.1136
Talent training C_8	0.6548	0.6548	0.7147	0.7147	0.7403	0.7403	0.7608	0.7608	0.7352	0.7352
Teaching and research results C_9	0.2498	0.2498	0.2185	0.2185	0.2037	0.2037	0.1912	0.1912	0.2067	0.2067
Economic performance of the industry C_{10}	0.0954	0.0954	0.0668	0.0668	0.0560	0.0560	0.0480	0.0480	0.0581	0.0581

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Table 6. The weighted ultra matrix between elements at the norm of assets management level in institutions of higher education

	Personnel C_1	Capital C_2	Equipment C_3	The purchase of assets C_4	The use of assets C_5	The maintenance of assets C_6	The disposal of assets C_7	Talent training C_8	Teaching and research results C_9	Economic performance of the industry C_{10}
Personnel C_1	0.0861	0.0861	0.0895	0.0895	0.0728	0.0728	0.0788	0.0788	0.0763	0.0763
Capital C_2	0.2123	0.2123	0.2048	0.2048	0.2382	0.2382	0.2272	0.2272	0.2318	0.2318
Equipment C_3	0.0349	0.0349	0.0391	0.0391	0.0222	0.0222	0.0273	0.0273	0.0252	0.0252
The purchase of assets C_4	0.0228	0.0228	0.0318	0.0318	0.0228	0.0228	0.0212	0.0212	0.0163	0.0163
The use of assets C_5	0.1764	0.1764	0.1558	0.1558	0.1764	0.1764	0.1803	0.1803	0.1941	0.1941
The maintenance of assets C_6	0.0894	0.0894	0.0924	0.0924	0.0894	0.0894	0.0880	0.0880	0.085	0.085
The disposal of assets C_7	0.0447	0.0447	0.0534	0.0534	0.0447	0.0447	0.0439	0.0439	0.0379	0.0379
Talent training C_8	0.2183	0.2183	0.2382	0.2382	0.2468	0.2468	0.2536	0.2536	0.2451	0.2451
Teaching and research results C_9	0.0833	0.0833	0.0728	0.0728	0.0679	0.0679	0.0637	0.0637	0.0689	0.0689
Economic performance of the industry C_{10}	0.0318	0.0318	0.0223	0.0223	0.0187	0.0187	0.016	0.016	0.0194	0.0194

Table 7. The margin ultra matrix

	Personnel C_1	Capital C_2	Equipment C_3	The purchase of assets C_4	The use of assets C_5	The maintenance of assets C_6	The disposal of assets C_7	Talent training C_8	Teaching and research results C_9	Economic performance of the industry C_{10}
Personnel C_1	0.0822	0.0822	0.0822	0.0822	0.0822	0.0822	0.0822	0.0822	0.0822	0.0822
Capital C_2	0.2199	0.2199	0.2199	0.2199	0.2199	0.2199	0.2199	0.2199	0.2199	0.2199
Equipment C_3	0.0312	0.0312	0.0312	0.0312	0.0312	0.0312	0.0312	0.0312	0.0312	0.0312
The purchase of assets C_4	0.0223	0.0223	0.0223	0.0223	0.0223	0.0223	0.0223	0.0223	0.0223	0.0223
The use of assets C_5	0.1784	0.1784	0.1784	0.1784	0.1784	0.1784	0.1784	0.1784	0.1784	0.1784
The maintenance of assets C_6	0.0886	0.0886	0.0886	0.0886	0.0886	0.0886	0.0886	0.0886	0.0886	0.0886
The disposal of assets C_7	0.0440	0.0440	0.0440	0.0440	0.0440	0.0440	0.0440	0.0440	0.0440	0.0440
Talent training C_8	0.2380	0.2380	0.2380	0.2380	0.2380	0.2380	0.2380	0.2380	0.2380	0.2380
Teaching and research results C_9	0.0726	0.0726	0.0726	0.0726	0.0726	0.0726	0.0726	0.0726	0.0726	0.0726
Economic performance of the industry C_{10}	0.0228	0.0228	0.0228	0.0228	0.0228	0.0228	0.0228	0.0228	0.0228	0.0228

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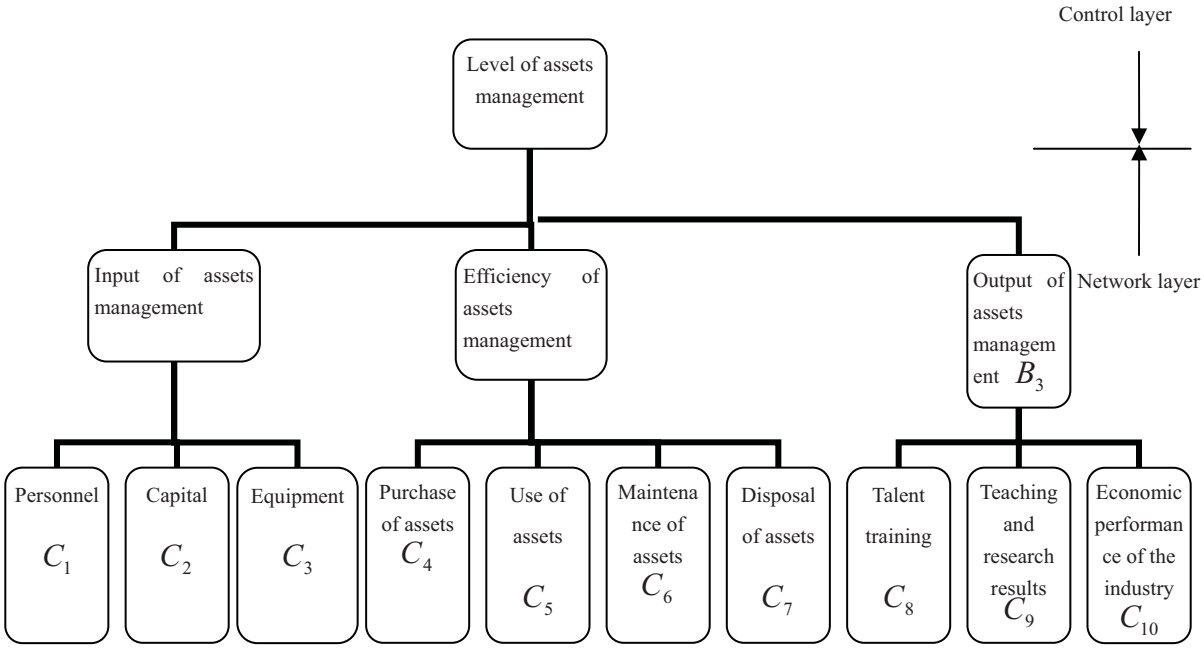

Figure 1. The network process structure model