Design Engineering

ISSN: 0011-9342
Issue: 1 | Pages: 430 - 436

Fuzzy Evaluation Model of Innovative Talents Based on Analytic Network Process

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Abstract:

By analyzing the research status of comprehensive evaluation of innovative talents at home and abroad, on the basis of referring to the existing research results, the comprehensive evaluation index system of innovative talents in Colleges and universities is constructed from five aspects: knowledge structure, innovative skills, physical quality, innovative thinking and spirit, and personal quality. This paper uses network analytic hierarchy process (AHP) and super decisions software to solve the problem of relative importance weight of indicators, and tries to use this method to make a more scientific, reasonable and accurate evaluation of innovative talents in Colleges and universities.

Keywords*: Universities; Innovative talents; ANP; Evaluation index system.*

I. INTRODUCTION

Today, with the development of multi polarization, the deepening of economic globalization and the rapid progress of science and technology, innovative talents are becoming more and more decisive in the competition of comprehensive national strength. College students are the reserve team of innovative talents nowadays. Recently, theoretical circles pay more attention to researching training mode of innovative talents in universities and colleges, but ignore objective evaluation of innovative talents. What are innovative talents?At present, there is no unified understanding at home and abroad [1]. Talent evaluation is the identification degree of talents. Correct, fair and fair evaluation of talents can discover and protect talents; wrong evaluation of talents will bury talents and waste talents [2]. The evaluation of innovative talents is a complex problem with many factors, most of which are qualitative descriptions. Establishing an objective evaluation index system of innovative talents, quantifying the qualitative problems, and making use of the evaluation objectives can play a "guiding" role in students development.

II. CONSTRUCTION OF COMPREHENSIVE EVALUATION INDEX SYSTEM FOR INNOVATIVE TALENTS IN COLLEGES AND UNIVERSITIES

2.1 Basis of Index System Construction

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Innovative talents are the comprehensive reflection of many factors and indexes. There are many factors, and the structure is complex. Only by analyzing and establishing the evaluation index system from multiple angles and levels can we reflect the innovation level of college students scientifically and accurately. To this end [3,4]:

(1) Based on the theory of multiple intelligences, combined with the definition of innovative talents by domestic and foreign educators, this paper establishes the comprehensive evaluation index of innovative talents;

(2) Based on the index of authoritative literature, and following the principles of scientificity, systematization, guidance, combination of qualitative evaluation and quantitative evaluation, focusing on practical results and operability, combining self-evaluation with other evaluation and paying attention to self-evaluation, a comprehensive evaluation index system for innovative talents in Colleges and universities is established.

2.2. The construction principle of comprehensive evaluation index system for innovative talents

(1) Scientific principle. It includes the accuracy and comprehensiveness of the index system. Scientificity of the index system is the premise of the evaluation. Only under the premise of ensuring the scientificity can the evaluation have a reliable basis.

(2) Guiding principle. The basic purpose of the evaluation of innovative talents is to implement the policy of innovative education, make use of the evaluation objectives, make students' knowledge, ability and quality get comprehensive development, guide studentson their development, and cultivate their innovative spirit as well as improve their innovative ability.

(3) The principle of combining qualitative evaluation with quantitative evaluation. Qualitative evaluation mainly relies on descriptive language to express from the qualitative aspect; quantitative evaluation is to quantify the results of qualitative evaluation, so as to make a more detailed analysis and evaluation, which can make the description of qualitative analysis conclusion more intuitive and convincing. Therefore, when designing the index system of College Students' innovation ability, we should focus on the combination of qualitative evaluation and quantitative evaluation.

(4) The combination of self-evaluation and other evaluation, and pay attention to the principle of self-evaluation. It is necessary to change the static summative evaluation which is based on other evaluation because the purpose of traditional evaluation focuses on utilitarianism. If the way of evaluation is only other evaluation, students' independent consciousness, innovative spirit and competitive concept cannot be fully developed and improved. Paying attention to self-evaluation and really letting students participate in the whole process of evaluation can not only overcome the shortcomings of other evaluation, but also promote students' lifelong development, which is conducive to the continuous improvement of innovation ability.

2.3 Comprehensive Evaluation Index System of Innovative Talents

According to the construction principle of the comprehensive evaluation index system of

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innovative talents, this paper establishes an index system with 21 indexes, including 5 standard levels of quantitative and non quantitative indexes. The details are shown in TABLEI.

III. ESTABLISHMENT OF COMPREHENSIVE EVALUATION MODEL OF INNOVATIVE TALENTS IN COLLEGES AND UNIVERSITIES BASED ON ANP

3.1 Basic Principle of ANP

The core of AHP is to consider only the dominating effect of upper elements on lower elements. The elements of the same layer are independent of each other. In the complex system evaluation and decision-making. Each factor is often interdependent. There is a dependency relationship within the same level elements, and there is also a dependency relationship between the lower level elements and the upper level elements. At this time, the system structure is network. Network analysis is just to meet this need.AHPcan deal with complex decision-making problems with internal dependence and external feedback. Firstly, ANP divides the system elements into two parts [5]. The first part is called control factor layer, which includes problem objectives and decision criteria. The second part is the network layer, which is composed of all the element groups controlled by the control layer (also known as the primary factor). The network structure is composed of the mutual influencing element groups (also known as secondary factors) (Fig 1).

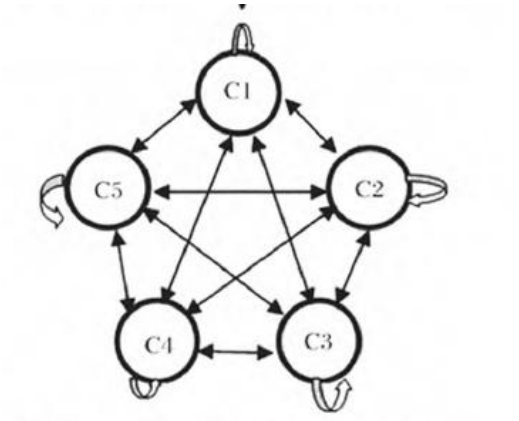

Fig 1: ANP network structure circle of University Innovative Talents comprehensive evaluation

3.2Calculation Principle of ANP Index Weight

(1) Advantage of question and answer

A criterion is given, under which the influence of two elements on the third (called subcriteria) is compared. For example, in order to compare the creative interests and motivations of members a and B, we can obtain them indirectly by comparing the papers published by members a and B. This method is different from the traditional AHP direct comparison method. It is suitable for ANP model when the elements are interdependent.

(2) Weight matrix

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The weight matrix is to construct the interaction between the network layer element groups, as shown in TABLE II, that is, the relative importance of each element group to C_i (i = 1, 2,..., n) under the control layer elements Ps (s = 1, 2,..., m). Different from the construction of judgment matrix in AHP, if one element has no effect on other elements in the judgment matrix of ANP, the value at this point in the judgment matrix is 0, the value in the corresponding eigenvector is also 0, and the others are normalized.

TABLE I. Weight matrix

C_i	$C_1 \ldots C_n$	Normalized eigenvector
C_1	Judgment matrix	a_{1i}
C_n		a_{ni}

Among them, the last column "normalized eigenvector" is calculated by using the method of specific eigenvector in AHP according to the judgment matrix, so each group of normalized eigenvectors is obtained according to the consistency test of judgment matrix constructed in AHP.

The weighted matrix A is obtained by combining all the normalized eigenvectors into a matrix.

$$A = \begin{pmatrix} a_{1i} \cdots a_{1n} \\ a_{n1} \cdots a_{nn} \end{pmatrix}$$

Here, a is a nonnegative matrix with column sum I, and there are m elements in the control layer, so there are m matrices similar to a.

(3) Hypermatrix

The super matrix constructs the degree of interaction between elements under sub criteria, that is, the degree of interaction between sub factors. Let there be elements (i.e. sub factor) e_{i1}, e_{i2},..., e_{iN} (i = 1,2,..., n) in CI, take the control layer element Ps (s = 1, 2,..., m) as the criterion, and the element e_{ik} (k = 1, 2,..., Ni) in C_i (i = 1, 2,..., n) as the secondary criterion. The dominance of elements in element group C_1, C_2,..., C_n is judged according to their influence on e_{ik}, that is, the construction of judgment matrix is shown in TABLE III.

TABLEII. Hypermatrix

e_{ik}	$e_{il} \ldots e_{iNi}$	Normalized eigenvector
e_{i1}	Judgment matrix	w_{i1}
e_{iNi}		w_{ik}

All such matrices are composed of block matrix, and the hypermatrix of nine is finally obtained.

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$$W = \begin{pmatrix} W_{11}W_{12}\cdots W_{1n} \\ W_{21}W_{22}\cdots W_{2n} \\ \cdots \\ W_{n1}W_{n2}\cdots W_{nn} \end{pmatrix}$$

(4) Weighted hypermatrix

The weight matrix constructs the mutual influence degree between the elements, and the hypermatrix constructs the mutual influence degree among the elements under the element group. Then the actual influence relationship between the elements in ANP with subordinate and feedback relations can be expressed by weighted hypermatrix.

Weighted hypermatrix $\overline{W} : \overline{W} = \left(\overline{W}_{ij}\right) : \overline{W}_{ij} = a_{ij} W_{ij}$

Then the weighted hypermatrix W is a nonnegative matrix with column sum of 1, which is called column random matrix. For the sake of simplicity, the weighted hypermatrix is hereinafter referred to as a hypermatrix and is still represented by W.

IV. A CASE STUDY ON COMPREHENSIVE EVALUATION OF INNOVATIVE TALENTS IN COLLEGES AND UNIVERSITIES BASED ON ANP

Rozann w. satry and William Adams introduced super decisions (SD) software in the United States, which is based on ANP Theory. ANP has been successfully programmed, which is a powerful tool for ANP calculation and lays a foundation for the popularization of ANP. SD software provides powerful functions to calculate any ANP model and express the calculation results completely.

For the established comprehensive evaluation index system of innovative talents in universities and colleges. In the following, we use super decisions software to realize the ANP Method to weight the indicators. Firstly, the ANP model of comprehensive evaluation of innovative talents in Colleges and universities is made

According to the above ANP model structure diagram, the following example shows how to use superdecisions software to calculate each index's weight. The key is to compare elements importance.

Superdecisions software provides matrix, questionnaire, oral and graphic input data to determine the judgment value. All those with interdependence and feedback are compared. The scale values of dominance are shown in TABLE III.

TABLEIII. Dominance scale value table

Scale	Representative meaning
1	Factor i is as important as factor J
3	i factor is slightly more important than J factor
5	i factor is more important than J factor
7	The ratio of i factor to J factor is very important

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9	i factor is more important than J factor
2,4,6,8	Scale values corresponding to the above intermediate states

V. CONCLUSION

On the basis of ANP method, this paper establishes a comprehensive evaluation index system of innovative talents in universities and colleges by adding non intelligence factors such as personality quality and physical quality of college students, so as to make a more scientific, reasonable and accurate evaluation of innovative talents in Colleges and universities. By using analytic network process (ANP) and combining qualitative and quantitative methods, a more complete and effective network hierarchy model is established, and the corresponding weights of indicators are given scientifically.

According to the calculation results, 73% of the influencing factors of innovative talents are determined by non intelligence factors, while only 27% are determined by intellectual factors; personality quality accounts for 44.2% of the whole evaluation system of innovative talents. This system has broken the previous evaluation mode that innovative talents attach importance to intellectual factors but despise non intellectual factors, and has broken the other evaluation method of evaluating innovative talents by innovative achievements. It has established a comprehensive evaluation system which combines performance evaluation method with self-evaluation method including innovative achievements.

The practice shows that the evaluation system has strong operability, which makes the evaluation method of innovative talents in Colleges and universities tend to be standardized and modernized, and can comprehensively reflect the evaluation results.The evaluation of innovative talents is conducive to the correct self-diagnosis, understanding of their strengths and weaknesses, finding out the existing gaps, problems and weak links, so as to foster strengths and circumvent weaknesses and develop in an all-round way. To a certain extent, it guides and encourages college students to consciously innovate, compete and strive for excellence, and strive for the direction required by indicators, which will greatly optimize the education environment and make innovative talents stand out as soon as possible.

ACKNOWLEDGEMENT

The research in this paper was supported by Higher Education Teaching Reform Project in Zhejiang Province in 2016: “Research on the Cultivation of Innovative Technical Skills in Higher Vocational Colleges--Taking Business Administration as an Example”(NO. JG20160290).

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