Polygraph Survey and Evaluation Based on Analytic Hierarchy Process

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Abstract

The analytic hierarchy process (AHP) is a kind of combining quantitative analysis and qualitative analysis of comprehensive evaluation method. In modern personality test, lying is a common phenomenon. This paper combined with the actual survey results, using AHP to measure the process of empowerment, in fact is through the hierarchy model is set up as index system, the subjective indicators of two comparison and evaluation, through the judgment matrix to calculate the weight coefficient of every index. After through the consistency check, corresponding to hiring and personality assessment to empowerment in school keep file, in order to obtain better truth, accuracy, so as to realize are established for the big five personality test scores, to a certain extent, to avoid lying, better more authenticity of the test results.

Keywords: analytic hierarchy process, polygraph, personality test improved

1. Introduction

Analytic hierarchy process (AHP) is a combination of qualitative and quantitative analysis of decision-making method [1, 2]. It can be the element that related to decision-making is decomposed into goals, principles, scheme, such as level, on the basis of the decision-making method for qualitative analysis. This method has the advantages of system, flexible and concise [3]. As a kind of quantitative analysis and qualitative analysis can be combined with the comprehensive evaluation method, AHP has been widely used in the actual life [4-12].

Along with the people understanding of mental health and attaches importance to ascend, all sorts of psychological evaluation also began a wide range of applications. The personality test as a foundation for a more basic measure of individual character, interest form special brought to the attention of the society. Many colleges and universities in our country and the enterprises and institutions to their students or staff conduct regular personality psychological evaluation. At the same time, more and more units began to adopt a variety of personality assessment as a testing point in the recruitment process, to ensure that the recruitment of staff not only ability outstanding healthy and have good psychological quality. Cognitive tests to measure the individual have a certain degree of cognitive ability, so don't consider the factor of speculation, subjects only to know the right answer to score [13].

And the personality test is different; the subjects could score at will. Test questions for attention, for example, "I usually hard to concentrate on the things at hand", if the subjects to answer "no", suggests that he can concentrate on things, but the relatively has a low concentration of people can also answer "no", easily to achieve some expected results by fraud. So how to and around the recruitment process for this kind of situation in the personality test in the school archives lie seems to be very necessary. The traditional detecting method have set some difficult to give false title, or ask some questions about ambiguity to measure by. A better way to have a false identification scale [13, 14] .In order to eliminate the personality assessment part lies in the process of application situation in our country, the introduction of frequency adverbs in order to improve strength lies, in the hope of relief, such as in this paper, we study in the research of the big five personality inventory. But in reality, the strength of the frequency adverbs choice also faces lie.

Based on a five level measure frequency adverbs is completely does not conform to, comparison does not conform to, in general, compared with, more in line with the big five

personality test to study the people to solve the problem of the frequency of lying in the personality test, and with the aid of AHP to measure with five levels of frequency adverbs of test scores, with the aid of mathematical tools to achieve better effect of lie detector.

2. Big Five Personality Test
2.1. Big Five Personality Test Simplified Test Table

AHP can be used in the multi-index comprehensive evaluation of empowerment. In multi-index comprehensive evaluation of each index for criterion layer and target layer, its influence is not exactly the same size and function, namely the index for total evaluation, is not as important. As this article selected in the measurement of the big five personality scale, based on all the adverbs of frequency is equal to score the gradient of 1 is divided into hierarchically) gradient (in absolute value, finally, according to all kinds of other subject belongs to the total marks on a scale of personality. This way of evaluation in subjects lie score difference obviously, so it is may be produced in hiring and keep file applications prone to poor authenticity. The big five personality test with a simplified version of the table is as follows:

Table 1. Simplified Version of the Big Five Personality Test

1. I am not a man who is full of troubles.	31. I rarely felt sad or depressed.
2. I really like most of the people I met.	32. The rhythm of my life soon.
3. I don't like to waste time to daydream.	33. I often go to try new and foreign food.
4. I will attempt to doubt and irony others.	34. Most of the people all know me like me.
5. On the job, I am efficient and capable.	35. When I made a promise, I can usually carry out to the end.
6. I seldom feel fear and anxiety.	36. Most of the time, when something is wrong, I will feel frustrated and want to give up.
7. I like talking with others.	37. I am a very active person.
8. The laws of nature and art forms to make me feel very mysterious.	38. I like thinking and playing with theory or abstract concept.
9. I believe that if you allow others to take advantage of you, a lot of people will do it.	39. I would rather work with people, rather than compete with people.
10. I'll keep my items neat and clean.	40. I have a clear set of goals, and methodically work towards it.
11. I often feel nervous and distracted.	41. Sometimes I want to hide for very shame.
12. I like a lot of people around me.	42. I like illustrates its, in the event.
13. I have only a little feeling even poetry.	43. I have no interest in thinking about the laws of the universe or the human condition.
14. If you need, I will achieve what I want to manipulate others.	44. If I don't like someone, and I'll let him know.
15. I'm not a methodical person.	45. I tried to finish my goal.
16. Others treat me the way often makes me angry.	46. I often feel inferior to others.
17. When I read a poem or enjoy a work of art, I sometimes feel excited or surprise.	47. I'm not an optimist.
18. I always prefer to work alone.	48. I'm idealistic things full of curiosity.
19. Some people think I am selfish and self-centered.	49. I often argue with my family and colleagues.
20. It seems I always can't put things in order.	50. I will be the pursuit of excellence in all things.
21. I seldom feel lonely or sad.	51. I often feel helpless and hope someone can solve my problem.
22. I'd rather do myself than to be the leader of the people.	52. I am happy,
23. I seldom pay attention to your emotions or feelings in different environment.	53. I believe that let the students listen to very controversial speech will only confuse and mislead their thoughts.
24. Some people think I am cold and calculating.	54. I have a high evaluation to myself.
25. I will complete all assigned to it to the best of my work.	55. I quite can according to their own pace, to get things completed on time.
26. Sometimes I feel completely worthless.	56. When I am under great pressure, sometimes I feel like a mental breakdown.
27. I often feel energetic.	57. I'm easy to laugh.
28. When I found the correct way to do things, I will insist on using this method.	58. I think that decisions on ethical issues, we should follow the religious authority.
29. I usually try to thoughtful and considerate.	59. On the attitude, I am a stubborn no compromise.
30. Sometimes I can't do I should be honest or trustworthy.	60. I'm going to take a lot of time to settle down to work.

With five adverbs of frequency measurement of the big five personality, include option is not in conformity with the completely, more do not conform to, generally, compared with and fully comply with five gradient. This test, the option does not conform to the score value is 1, the option value increase one 1 score, adjacent to the option completely conform to the score value of 5.

2.2. Five Test Score Standards
Each question from completely does not accord with to fully comply with respectively 1, 2, 3, 4, 5 points.
Nervous: Item: 1 6 11 16 21 26 31 36 41 46 51 56 Among them: 1 6 21 31, reverse score.
Extroversion: Item: 2 7 12 18 22 27 32 37 42 47 52 57 Among them: 18 22 47, reverse score.
Openness: Item: 3 8 13 17 23 28 33 38 43 48 53 58 Among them: 3 13 28 43 53 58, reverse score.
Friendly: Item: 4 9 14 19 24 29 34 39 44 49 54 59 Among them: 4 9 14 19 24 44 49 54, reverse score.
Conscientiousness: Item: 5 10 15 20 25 30 35 40 45 50 55 60 Among them: 20 30 60, reverse score.

2.3. The Questionnaire and the Results of the Survey
1. When you need to complete a questionnaire deposited in the archives or apply for a job can be used, if you will choose to lie in order to obtain better results.
   A. will   **B**. will not
   2.Whether can be found in the test subject is good for me?
   A. Yes   **B**. No
   3. When found the problem content against you, you will choose?
   A. lighter than the actual levels of the answer   **B.** The answer to a neutral
   C. Elected a favorable answer directly   **D.** Select the option that conform to mine
   4. When you found the problem content in your favor, you will choose?
   A. A height than the actual levels of the answer   **B.** The answer to a neutral
   C. Choose the strongest options directly   **D.** Select the option that conform to mine

Table 2. The Survey Results

ABBA	AABA	AABD	BABB	BBBA
AAAD	BABD	AACC	ABAD	BADD
BBDD	BADD	AABD	AABA	BADD
AABA	BADD	BAAD	AABD	AAAD
AABD	AACD	BADD	AAAD	BACD
BBDD	BADD	ABDC	BBBD	AABD
BADD	AABB	BADD	BBDD	BABD
AAAD	BADD	AABB	BABD	BADD
AAAD	BADD	BADD	BBDD	AABD
BBBA	AAAD	AAAD	BADD	AABD
BAAD	BAAD	BADD	BABC	ABBD
ABAD	AAAD	BBBD	BABC	BBBD
AABB	AACD	BADD	BADA	BABD
BADD	BABD	BACB	ABAD	AABD
BBBD	AABD	BBDD	BACC	BADD
BBAB	AABD	AACB	BAAD	BABD
BABD	AABD	AAAD	BAAD	ABBD
AAAB	BADD	BBBA	AABD	BBBD
ABAA	BBDD	BADD	AABD	AABD
BABB	AACD	BADC	BADD	ABAD
BBBD	BBAD	BAAA	BADC	AACC

3. Hierarchy Structure Model
3.1, Modeling
In actual survey, as does not provide any of the big five personality test questions, there is a certain percentage of the students said that they could not distinguish whether the title to

their advantage or disadvantage, so we cannot judge on whether to lie to. But the offer after several questions of the big five personality test, only a classmate said there are still some questions are difficult to distinguish whether for the specific scenario of default, the school archives or face when the company recruitment of choose and employ persons is favorable, lower percentage of overall investigated in view of the students, this article only to find the unfavorable factors appear more further discussion on the hierarchical structure model is set up as Figure 1.
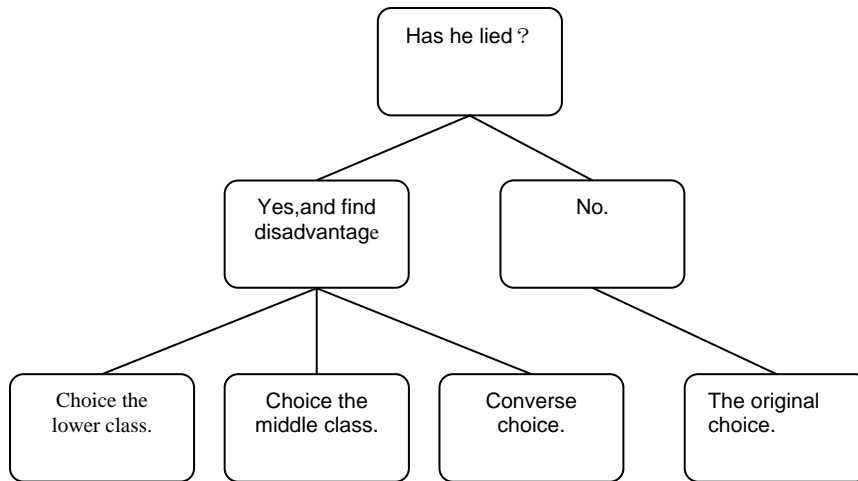

Figure 1. Hierarchy Structure Model of Lying Survey

Restricted by time and scope, this survey in several universities through paper questionnaire and network in the form of the first-year university undergraduate course to graduate student grade two students conducted a random survey, received reply to 105. The test of the four questions to a certain way to prevent these questionnaire participants lay. When dealing with evaluation questionnaire results, by 3, 4, topic both options as a standard actually honest answer, 1 topic choice for reference, a follow-up study, not be discussed in this paper. In the process of the above model, only for the third question in the questionnaire was discussed, which aimed at testing found in adverse to the subjects of a1 condition was discussed. In the choice to lie there are four people in the population to the third topic selected item, or for the third question answer them as honest option, therefore, in the process of calculation, the subject of the four options subjects were calculated on honest answer, in a higher level - not lying. Is for the final results of the third question was in 105 subjects, 80 people choose lie (containing the above four subjects). On the third question, 23 subjects of these options, 45 subjects' options, eight participants option, a total of 76 subject's selection against what they think the problem lies.

3.2. Solution Method for Model
According to the model, based on the actual survey data, approximately take scale paired comparison matrix is established. The following:

Table 3. The Importance Scale of 1 ~ 9 Scale

Measure a_{ij}	1	3	5	7	9
The importance of $C_i : C_j$	equal	A bit better	better	Obviously strong	Absolute strong

Where, 2, 4, 6, 8 is the middle class between the above [2].

Selection of paired comparison matrix $\begin{pmatrix} 1 & 1/2 & 3 \\ 2 & 1 & 6 \\ 1/3 & 1/6 & 1 \end{pmatrix}$. Obviously this matrix is

consistent matrix; do not need to do the consistency check. Operations with the help of MATLAB software, paired comparison matrix get the biggest characteristic root of paired comparison matrix and the corresponding eigenvectors, the 3 biggest characteristic roots and its corresponding eigenvectors (0.3000, 0.6000, 0.1000).

Put the feature vector is multiplied by the number of total questionnaire response to lie purpose ratio combination weight vector (0.2171, 0.4343, 0.0724). Test each arithmetic is a raw score value of 1, score value from 1 to 5, which completely accords with the scores of option value of 5 points. Through calculation, the test survey showed that if a certain subjects completely accords with the subject of a against it, it's were 21.71% more likely to choose is conform to, 43.43% probability of selection, and 7.24% probability of selection is not in conformity with the completely. On the basis of the original score value was improved, the income difference of corresponding points between weight and options multiply coupled with the option of the original is worth to the new score, namely the option compared with a value of 4.2171 points score, options generally score value of 3.8686 points, option does not conform to the 1.2896 points, fully meet and option comparison is not in conformity with the grades remain the same, still is 5 points and 2 points. At the same time keep its test the original scale division.

Under the scale, the actual survey results are in the process of the structure of the Judging matrix, found to have higher levels of approximation components, that may Affect the results. In order to improve the accuracy of the results, can change the way That the scale, improve the accuracy of judging matrix in order to obtain more accurate results. Using $10/10 \sim 18/2$ scale [15], judging matrix constructed by actual survey results and to calculate again.

Table 4. 10/10 ~ 18/2 Established Degree of the Importance of the Dimension Table

measure a_{ij}	1	1.5	2.333	4	9
The importance of $C_i : C_j$	equal	A bit better	better	Obviously strong	Absolute strong

Where the importance of dimension a_{ij} level division can use the formula said $\dfrac{9+k}{11-k}$,

among k take 2,4,6,8 for intermediate values that as shown in the table above between adjacent levels. Accordingly to get the scale of paired comparison matrix.

$$\begin{pmatrix} \dfrac{10}{10} & \dfrac{7}{13} & \dfrac{15}{5} \\ \dfrac{13}{7} & \dfrac{10}{10} & \dfrac{17}{3} \\ \dfrac{5}{15} & \dfrac{3}{17} & \dfrac{10}{10} \end{pmatrix}$$

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10/10 ~ 18/2 were calculated with the help of MATLAB software is established degrees above the maximum characteristic root paired comparison matrix and the corresponding eigenvectors, get the maximum characteristic root of 3,Its feature vector is (0.3107,0.5857, 0.1035).

Consistency inspection:

$$CI = \frac{\lambda_{\max} - n}{n-1} = \frac{3-3}{3-1} = 0 \quad CR = \frac{CI}{RI} = 0 < 0.1$$

Results through the consistency test. The characteristic vector multiplied by the number lies with the amount of questionnaire response purpose ratio combination weight vector (0.2249, 0.4240, 0.0749). After calculation, under the scale of 10/10~18/2, if a certain subjects completely accords with the subject of a against its, he were 22.49% more likely to choose match, 42.40% probability of selection, and 7.49% probability of selection is not in conformity with the completely. The results closer to the actual survey data, therefore have higher credibility. According to this scale score value to improve the original score value, the income difference of corresponding points between weight and options multiply and add this option is worth to original new scores, one option is in line with the score value of 4.2249 points, options generally score value of 3.8480 points, option does not conform to the 1.2996 points, option fully meet and option comparison is not in conformity with the grades remain the same, still is 5 points and 2 points. At the same time keep its test the original scale division.

4. Conclusion

For the measure lying problem, this paper give a new method that use AHP to set up index system to the subjective indicators of two comparison and evaluation. After through the consistency test, we give the power coefficients to the personality assessment in the company recruitment process and school keeping file. We establish test scores for the big five personality to avoid lying. Not only that, in the calculation of the problem, the scale of calculation accuracy than conventional under the scale of calculation accuracy is higher, so the data of the former as a reference, in order to achieve a higher credibility.

References

[1] Saaty, Thomas L. The Analytic Hierarchy Process. New York: McGraw Hill. 1981.
[2] Jiang QY, Xie JX, Ye J. Mathematical Model (The fourth edition). BEIJING: Higher Education Press. 2011.
[3] Li Y, Zhu JS. An Improvement and Its Application of AHP. *Electronic Design Engineering.* 2011; 19(15): 29-35.
[4] Du LN. Multi-attribute Decision Making by Analytic Hierarchy Process. *Journal of Gansu Lianhe University (Natural Sciences).* 2007; 21(5): 31-35.
[5] Thomas L Saaty. Decision making with the analytic hierarchy process. *Int. J. Services Science.* 2008; 1(1): 83-98.
[6] Liao HQ, Qiu Y, Yang X, Wang XG, Ge RW. A Study of Weight Coefficient Computing Method Based on AHP. *Mechanical Engineer.* 2012; (6): 22-25.
[7] Deng X, Li JM, Zeng HJ, Chen JY, Zhao JF. Research on computation methods of AHP weight vector and its applications. *Mathematics in practice and theory.* 2012; 42(7): 93-100.
[8] Li Z, Zhou SG, Wang K. A Method for Constructing Perfectly Consistent Judgment Matrix in AHP. *Journal of Zhengzhou University (Nat. Sci. Ed.).* 2008; 40(1): 41-46.
[9] Gao S. Three Calculating Weights Methods in Analytic Hierarchy Process. *Science Technology and Engineering.* 2007; 7(20): 5204-5207.
[10] Wang H, Ma D. Scale Evalution and New Scale Methods. *Systems Engineering Theory and Practice.* 1993; 13(5): 24-26.
[11] Xu K, Liang XC. Guarantee Agency Efficiency Evaluation Based on Super Efficiency DEAAHP Model. *TELKOMNIKA Indonesian Journal of Electrical Engineering.* 2013; 11(7): 3981-3989.
[12] Liu LL, Chen H, Zhang RX. *Comprehensive Evaluation of Examination Quality Based on Fuzzy AHP.* 2013; 11(9): 5384-5394.
[13] Luo F, Zhang HC. Methods of Coping with Faking of Personality Tests. *Psychological Exploration.* 2007; 27(4): 78-82.
[14] Zuo HN, Liao FL. Methods of Lie Detection of Personality Test. *China Journal of Health Psychology.* 2009; 17(4): 505-507.
[15] Wu SQ. The Application of Improved AHP to Enterprise Information Evaluation Index Weight. *China Management Informationization.* 2011; 14(11): 53-55.