Evaluation of the Effectiveness of Knowledge Transfer between Enterprise Mentoring and Apprenticeship Based on the AHP-FCE Model Set

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Abstract—The implementation of the modern apprenticeship system has alleviated the problem of the existing shortage of skilled talents in our country. However, there are few studies on the evaluation of the effectiveness of the implementation of modern apprenticeships in our country. The effectiveness of Mentoring-apprentice knowledge transfer is an intuitive manifestation of the implementation of the modern apprenticeship system in an enterprise, and it is of great significance for evaluating the work of the modern apprenticeship system in an enterprise. Based on the existing research, this paper establishes an evaluation index system, taking Luoyang equipment manufacturing industry as a sample, and established the AHP-FCE model to evaluate the effectiveness of its enterprise apprenticeship knowledge transfer. It is found that the effectiveness of knowledge transfer equipment manufacturing enterprises in Luoyang is generally very good, but the modern apprenticeship environment could be improved. Therefore, it is suggested that Luoyang equipment manufacturing industry should enhance the policy incentives of the government, universities and enterprises, and strengthen the depth and frequency of cooperation between vocational colleges, so as to fully optimize the modern apprenticeship environment.

Keywords- ***AHP-FCE*** model set; apprenticeship; knowledge transfer; equipment manufacturing

1. Introduction

Modern apprenticeship is an important breakthrough in solving the problem of supply and demand dislocation between the supply side of talent training and industrial demand, and an important way to achieve the goal of jointly cultivating skilled talents by both schools and enterprises. Mentoring also as known as master become the key personnel to train interns of the company. At present, the research hotspot of modern apprenticeship in China is the research on participants' willingness and influencing factors of modern apprenticeship, and there are very few studies on the effectiveness of enterprise implementation. In order to evaluate the effectiveness of the modern apprenticeship system on the knowledge transfer of enterprise masters and apprentices, this paper establishes an evaluation index system for the effectiveness of mastery and apprenticeship knowledge transfer by The Analytic Hierarchy Process and Fuzzy Comprehensive Evaluation method Evaluate the effectiveness, and propose solutions and reference opinions for the possible deficiencies and urgent problems in the implementation of the modern apprenticeship system.

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2. Materials and Methods

2.1 Analysis of the Influencing Factors

(1) Knowledge itself. In the process of enterprise team knowledge transfer, knowledge itself has obvious characteristics [1]. Polanyi (1967) divided knowledge into explicit knowledge and tacit knowledge according to whether the knowledge is communicative or not. Tacit knowledge cannot be expressed in writing, so it is difficult to formalize and communicate. The tacit degree of knowledge results in knowledge reception. It is difficult for the parties to fully understand and master this knowledge in a short time, thus affecting the quality of knowledge transfer. Kogut and Zander (1995) pointed out that the tacitness, complexity, expressibility and professionalism of knowledge all have a certain influence on knowledge transfer. Tacit knowledge is more difficult to transfer. Lippman and Rumelt believed that the association between knowledge can also become an obstacle between knowledge transfer and knowledge receiver [2].

(2) Subjects of knowledge transfer. In the enterprise apprenticeship knowledge transfer system, seniors act as corporate mentors to impart knowledge to apprentices, and juniors receive knowledge as apprentices. In the transfer process, the knowledge base of the master and the apprentice determines whether the knowledge transfer can take place. The willingness of the master and the apprentice provides the possibility for knowledge transfer, and the "quantity" of the knowledge transfer is determined by the transfer ability of the knowledge transfer party and the knowledge receiver's ability to transfer. Learning ability determines[3]. Therefore, this paper argues that the factors affecting the effectiveness of knowledge transfer between master and apprentice are composed of the foundation, willingness and ability of both masters and apprentices.

(3) Knowledge transfer process. Organizational climate and communication quality are two factors that affect the process of knowledge transfer. O'Dell & Grayson (1998) pointed out that the greater the knowledge distance between the two sides of knowledge transfer, the greater the difficulty of knowledge transfer [4]. Madhok (2011) proposed that the stronger the trust relationship between knowledge transfer parties, the stronger the willingness to transfer knowledge [5]. Similarly, the stronger the learning atmosphere of the team organization environment, the higher the learning enthusiasm of the knowledge recipient, and the better the effectiveness of knowledge transfer.

(4) Modern Apprenticeship Environment. Situational elements of the main body of modern apprenticeships affect the effectiveness of knowledge transfer between mentoring and apprenticeship [6]. Gu Baoguo (2006) pointed out that performance determines system coordination and its speed and path, and enterprise system can improve the performance of knowledge transfer [7]. Liu Chunyan (2017) believed that as the participants of the modern apprenticeship system, the relevant policy incentives of the government, enterprises, universities and scientific research institutions can effectively improve the performance of knowledge transfer[8].

2.2 Construction of an Evaluation Index System

By sorting out the literature and analyzing the influencing factors of the effectiveness of enterprise mentoring knowledge transfer, the evaluation indicators are determined and the specific content is refined. Through analysis, we can get 5 secondary indicators of knowledge itself, 3 secondary indicators of knowledge transfer side, 3 secondary indicators of knowledge receiver,

7 secondary indicators of knowledge transfer process, and 6 secondary indicators of modern apprenticeship environment There are 5 secondary indicators for the effectiveness of master-apprentice knowledge transfer.

This paper adopts the analytic hierarchy process to determine the index weight. The Analytic Hierarchy Process (AHP) is a decision-making method for qualitative and quantitative analysis, proposed by American operations researcher T.L. Satty. Decompose complex problems into several layers such as the target layer, the criterion layer and the scheme layer, and through consulting relevant experts to construct a judgment matrix, calculate the weights and check the consistency, determine the importance weight of the decision-making scheme relative to the target, so as to obtain a more satisfactory result.

The analytic hierarchy method is more suitable for the target system with hierarchical and interleaved evaluation indicators, and the target value is difficult to describe quantitatively. According to the nature of the problem and the overall goal to be achieved, the analytic hierarchy method decomposes the problem into different constituent factors, and aggregates and combines the factors at different levels according to the interrelated influence and affiliation between the factors to form a multi-level analytical structure model, so that the problem is finally reduced to the determination of the relative important weights of the lowest level (schemes, measures, etc.) relative to the highest level (overall goal) or the arrangement of relative advantages and disadvantages. Therefore, it is very suitable to choose the hierarchical analysis method on the importance of the effectiveness of enterprise mentoring knowledge transfer, The calculation steps of AHP are as follows:

(1) Establish hierarchical structure model. Construct a judgment matrix. Experts are invited to scale 1-9, and to form a importance score matrix.

(2) Calculation of weights and consistency check. A total of 10 valid analytic hierarchy process questionnaires were recovered, and the software yaahp was used to calculate the weight and the consistency test.

If the largest eigenroot of A be λ_{max}, and its corresponding eigenvector be W, then

$$A*W=\lambda_{max}*W. \tag{1}$$

Consistency check CI (consistency, CI):

$$CI=\frac{\lambda max\text{-}n}{n\text{-}1} \tag{2}$$

λ_{max} is the largest eigenvalue of the matrix and n is the order.

At last, Calculate the consistency ratio CR..

$$CR=\frac{CI}{RI} \tag{3}$$

The calculated value of random consistency index RI is shown in Table 1.

Table 1 RI list

n	1/2	3	4	5	6	7	8	9	10
RI	0.00	0.58	0.90	1.12	1.24	1.32	1.41	1.45	1.49

When CR≤0.1, it indicates that the consistency of the determined judgment matrix is acceptable; when CR>0.1, it indicates that the degree of deviation of the judgment matrix from consistency is too large, and its relative importance value must be readjusted.

The consistency test of the analytic hierarchy method is an important step to test whether the results are reasonable, when the consistency test fails, the data should be checked, look for possible errors, and then take the minimum change method or the maximum improvement direction method to correct according to the situation. To ensure consistency testing are passed.

After consulting experts, questionnaires were distributed to experts who met the standards and returned, and a total of 13 valid questionnaires were returned. the expert status is the middle management personnel of the enterprise such as senior technicians, technical directors, technical experts and so on. The final evaluation index weights are shown in Figure 1

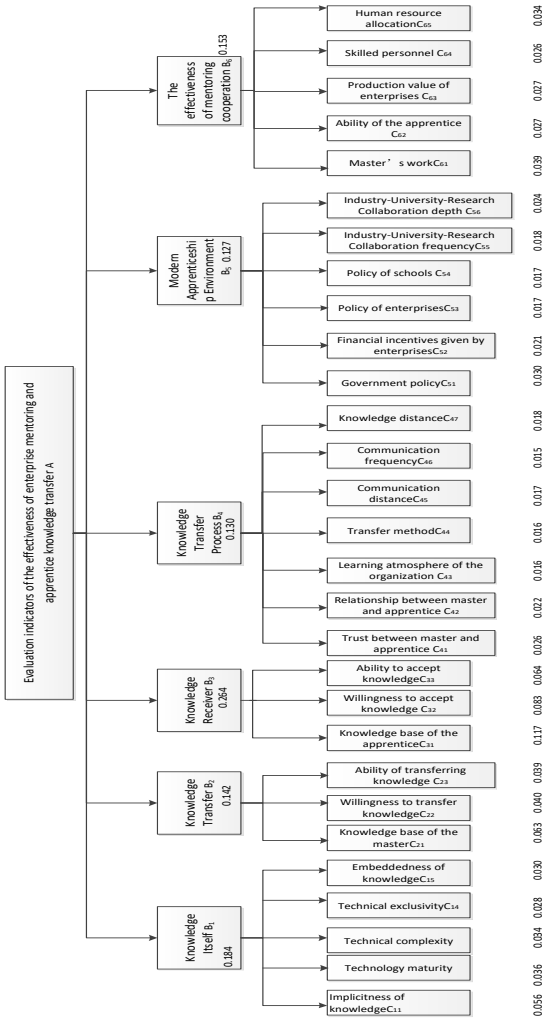

Figure 1 Index and Weight figure

3. Case Application

3.1 Data acquisition and analysis.

The subjects of the questionnaire survey were modern apprenticeship participants and some other employees of five equipment manufacturing enterprises in Luoyang. A total of 413 questionnaires were recovered, of which 395 were valid questionnaires, with an effective recovery rate of 95.64%.

3.2 Comprehensive Evaluation Theory

Fuzzy Comprehensive Evaluation (FCE) is a concept proposed by L.A. Zadeh in the United States, and it is a method for overall comprehensive evaluation of the characteristics of multi-factor systems based on fuzzy mathematics. Fuzzy comprehensive evaluation determines fuzzy sets and evaluation sets, establishes membership functions, constructs fuzzy evaluation matrix for fuzzy comprehensive evaluation, and quantifies some factors with unclear boundaries and difficult to determine, so it can more accurately reflect the inherent uncertainty of objective things and people's ambiguity in cognition. The calculation steps of fuzzy comprehensive evaluation are as follows:

(1) Determine the evaluation index set. Evaluation set :$B=\{B_1,B_2,B_3,B_4,B_5,B_6\}$.

(2) Determine the set of evaluation grades. In this study, $C=\{V_1,V_2,V_3,V_4,V_5\}$={very satisfied, satisfied, average, dissatisfied, very dissatisfied}={5, 4, 3, 2, 1}.

(3) Determine the weight of each evaluation index. The weight W is shown in the Figure 1.

(4) Determine the evaluation matrix R.

(5) Fuzzy comprehensive evaluation:

$$B=W*R \tag{4}$$

$$V=B*CT \tag{5}$$

3.3 Results

According to the questionnaire data, the fuzzy judgment matrix of index B_1 can be calculated.

$$R_1=\begin{bmatrix} 0.405 & 0.344 & 0.187 & 0.025 & 0.038 \\ 0.347 & 0.400 & 0.182 & 0.043 & 0.028 \\ 0.278 & 0.294 & 0.243 & 0.137 & 0.048 \\ 0.319 & 0.377 & 0.215 & 0.056 & 0.033 \\ 0.375 & 0.390 & 0.190 & 0.033 & 0.013 \end{bmatrix}$$

According to the formula (4), the judgment vector B_1 can be further obtained.

$$B_1 = W_1 R_1 =$$

$$\begin{bmatrix} 0.056 & 0.036 & 0.034 & 0.028 & 0.030 \end{bmatrix} * \begin{bmatrix} 0.405 & 0.344 & 0.187 & 0.025 & 0.038 \\ 0.347 & 0.400 & 0.182 & 0.043 & 0.028 \\ 0.278 & 0.294 & 0.243 & 0.137 & 0.048 \\ 0.319 & 0.377 & 0.215 & 0.056 & 0.033 \\ 0.375 & 0.390 & 0.190 & 0.033 & 0.013 \end{bmatrix}$$

$$= (0.065, 0.066, 0.037, 0.010, 0.006)$$

After normalization, B_1=(0.352,0.358,0.201,0.055,0.033).Similarly,

$B_2=W_2R_2$=(0.457,0.367,0.149,0.022,0.005)

$B_3=W_3R_3$=(0.354,0.385,0.227,0.024,0.010)

$B_4=W_4R_4$=(0.411,0.384,0.175,0.021,0.011)

$B_5=W_5R_5$=(0.315,0.292,0.294,0.070,0.028)

$B_6=W_6R_6$=(0.372,0.396,0.205,0.021,0.007)

B=WR=(0.374,0.367,0.210,0.034,0.015)

According to the formula (5), the effective value of the knowledge transfer of Luoyang enterprises can be calculated It is V=4.051, the result is between 4-5, and then each index score of V_1=3.880, V_2=4.249, V_3=4.025, V_4=3.944, V_5=3.793, V_6=4.108 is calculated respectively.

As score of 3 or more indicates that the knowledge transfer between apprentices and apprentices in Luoyang is very effect. So the evaluation result: the indicator “Knowledge Itself”, “Knowledge Transfer Process” and “Modern Apprenticeship Environment” scored between “average” and “satisfied”; the indicator “Knowledge Transfer”, “Knowledge Receiver” and “The effectiveness of mentoring cooperation" scored between “satisfied” and “very satisfied”.

4. Evaluation Results Analysis and Suggestions

By using fuzzy comprehensive evaluation to evaluate the effectiveness of knowledge transfer between apprentices and apprentices of five equipment manufacturing enterprises in Luoyang, it can be found that the modern apprenticeship environment is relatively comparable to other indicators. There is still room for improvement. Luoyang is a representative city of Chinese manufacturing industry. The current situation of Luoyang reflects most of the Chinese manufacturing industry to some extent, so its evaluation is representative and meaningful, so the following recommendations are made.

(1) The government should implement incentive policies to stimulate the enthusiasm of enterprises to participate in apprenticeships. As one of the main participants in the modern apprenticeship system, Compared with colleges and universities, enterprises, especially small and medium-sized enterprises, are not enthusiastic about participating in the modern apprenticeship system due to the provision of equipment, on-the-job internships, and financial support, the government should play a leading role and implement policy incentives[9].

(2) Policy formulation should attach importance to the supervisory role and guide the normal implementation of the pilot work. The 2019 "National Vocational Education Reform Implementation Plan" is a relatively complete policy document on the integration of production and

education in my country. However, the document does not provide a comprehensive description for the construction of the supervision mechanism. It should actively attract the participation of the whole people, and establish a comprehensive social multi-supervision system.

(3) Enterprises should optimize enterprise management and develop employees' knowledge transfer potential. The policies of the enterprise can directly affect the behavior of the employees. With the advent of the era of knowledge economy, more and more enterprises attach importance to knowledge management. However, there is a lack of consideration for the effectiveness of apprenticeships at the level of employee work performance assessment, so employees often lack enthusiasm for apprenticeship work. Introducing the incentive mechanism into the knowledge transfer process of enterprise apprenticeship can develop the knowledge transfer potential of the master and the knowledge acceptance potential of the apprentice.

5. Conclusions

In this study, the key elements of knowledge management of enterprise teachers were extracted by sorting out literature, and a two-level evaluation index system was established;The analytic hierarchy process method was used to complete the calculation of index weights; the fuzzy comprehensive evaluation method was introduced, and Luoyang, Henan Province Taking the city equipment manufacturing industry as a sample, a comprehensive evaluation was made on the effectiveness of the knowledge transfer between apprentices and apprentices in the equipment manufacturing industry in Luoyang City. From a national perspective, the application of this research is to comprehensively promote the effectiveness evaluation of enterprise mentoring knowledge transfer under the background of modern apprenticeship, and to establish a scientific and practical enterprise mentoring knowledge transfer effectiveness evaluation process and system, which has certain practical guiding significance.However, the model made in the paper has not been applied on a large scale, and the next step can further promote the model in the enterprise time.

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