

Research on the Evaluation System of Technical Talents in Oil and Gas Enterprises based on Competency Modelling

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Abstract

Under the background of "double carbon", oil and gas enterprises have put forward many new requirements on the competency of technical talents to realize sustainable development. In order to enhance the competence of technical talents of oil and gas enterprises and promote the high-quality development of oil and gas enterprises, this paper constructs the evaluation system of competence of technical talents of oil and gas enterprises through the methods of Del illegal and hierarchical analysis, analyzes the scientific rationality of 4 first-level indicators and 20 second-level indicators, and judges the influence of each level of indicators on the competence of technical talents of oil and gas enterprises based on the weighting scores, in order to provide assistance for the development of oil and gas enterprises. The evaluation system of oil and gas enterprises' technical talents competence is analyzed.

Keywords

Competency Modelling; Hierarchical Analysis; Delphi; Talent Evaluation.

1. Introduction

Under the environment that the whole world is actively responding to climate change, China's government has put forward the "dual-carbon" development strategy, which brings good development opportunities to the oil and gas industry and at the same time poses a serious challenge.[1] In this form of both opportunities and challenges, the sustainable development of oil and gas enterprises requires the synergy of excellent resources, and among the various resources, human resources, especially human resources, are the important foundation and guarantee for enterprises to achieve sustainable development, and are also the key factors for the vitality of enterprises to remain forever[2].

The Peak Carbon Action Program before 2030 pointed out that "we should promote the petrochemical industry to reach peak carbon, rationally regulate the consumption of oil and gas, and promote advanced bio-liquid fuels, sustainable aviation fuels and other alternatives to traditional fuels to strengthen the innovation capacity".[3]and on October 24, 2021, the "Opinions of the Central Committee of the Communist Party of China and the State Council on the Complete and Accurate and Full Implementation of the New Development Opinions of the CPC Central Committee and State Council on the Complete and Accurate Implementation of the New Development Concept to Do a Good Job of Carbon Peak and Carbon Neutral Work" was issued, which explicitly puts forward: building a carbon peak and carbon neutral talent system. [4]The non-renewable characteristics of oil and natural gas, coupled with the current dual goals of low carbon and efficiency, the requirements of technical research in the oil and gas enterprises are getting higher and higher, which puts forward new requirements for the technical talents of oil and gas enterprises. This paper uses hierarchical analysis to deconstruct the elements of competency of technical talents in oil and gas enterprises, obtains the data of

competency ratio through questionnaire survey of experts and scholars, and combines the scientific operation of hierarchical analysis to construct a more close to the actual competency framework, which is a positive impetus and realistic guidance for oil and gas enterprises to make full use of human resources, especially the talent resources, and to realize high-quality and sustainable development[5].

2. The Construction of Evaluation Index System of Oil and Gas Enterprises' Technical Talents

2.1. Indicator System for Technically Skilled Personnel in Oil and Gas Enterprises

Table 1. Evaluation indexes of competence characteristics of technical talents in oil and gas enterprises

Level 1 indicators	Secondary indicators	Definition of indicators
knowledge-related and skills	level of expertise	Knowledge of the industry and familiarity with the body of knowledge, research methods and theories in the specialised field, and a relevant degree
	Technical research capacity	Ability to solve technical problems and break through technical bottlenecks
	analytical and judgemental skills	Ability to analyse engineering test phenomena and data
	basic level of knowledge	i.e. academic level, including breadth and depth of knowledge, foreign language and computer skills, etc.
	Research capacity	The ability to use the scientific method to explore the nature and laws of things, i.e. the ability to raise questions, analyse problems and solve problems
	logical thinking	Clear logical thinking and ability to accurately grasp complex system architecture and frameworks
	Capacity for implementation	Ability to design a research programme based on the set objectives and to advance it rationally
trait	learning ability	Ability to update professional knowledge and skills in the course of formal or informal learning, ability to apply knowledge, and ability to learn from experience
	academic manner	Attitude and demeanour of rigour and truthfulness, academic integrity, and respect for the academic achievements of others, as demonstrated in academic research
	Creative thinking skills	Ability to think creatively about problems and constantly try new ideas and approaches to bring innovation to the business
	scientific attitude	An attitude based on objective facts, rational thinking and a critical spirit, including scepticism, openness, rigour and truthfulness, in scientific research and enquiry.
	scientific spirit	Attitude and values of thinking in the pursuit of truth, following objective laws, continuous exploration and innovation in scientific research
Work motivation and values	Core values	Have clear core values, ethics and cultural identity
	Individual technical upgrading	Continuously learn new knowledge and technology in the industry, and constantly improve your technical level and competitiveness
	sense of social responsibility	Contribute to society by actively participating in public welfare activities and social services
	Career Development Programme	Have a clear plan for your own career path and the corresponding implementation programme
personal management	conduct	Behavioural traits demonstrated at work, and a consistent style throughout the work process
	attitude	Evaluative and behavioural dispositions towards work, including conscientiousness, responsibility and effort.
	Innovations	Representative publications, chairing and participation in projects, patents and intellectual property rights
	Work performance	Achievements made during the actual work period and fulfilment of work assignments

Taking "talent evaluation" as the keyword, nearly 600 papers and related journals were searched, and from the literature review, there are many index systems on talent evaluation in the academic world, with their different focuses. Combining the characteristics of "iceberg model" and "onion model" in the competency model, the competency characteristics are stratified from the surface to the inside, and the evaluation index dimensions of skilled talents in oil and gas enterprises are determined based on the characteristics of skilled talents in oil and gas enterprises[6].

On the basis of theoretical guidance, in order to determine more reasonable and recognized talent evaluation indexes in combination with the actual situation of oil and gas enterprises, we used questionnaires to collect information on the reasonableness of the evaluation indexes, and completed expert consultation on the reasonableness of the indexes by using the Dufour method. This research questionnaire was distributed to experts related to oil and gas enterprise research, and 62 questionnaires were distributed and 62 were recovered for the research on competency characteristics indicators of technical talent evaluation. After repeated checking and confirmation, all the questionnaires were valid. Combined with the questionnaire data, the evaluation index dimensions of skilled talents in oil and gas enterprises were finally determined (see Table 1).

From the finalized evaluation indexes, the evaluation of technically skilled personnel in oil and gas enterprises focuses more on the examination of intuitive and directly perceivable competency characteristics.

2.2. Hierarchical Analysis Steps

2.2.1. Modelling the Hierarchy

According to the objective stratification in the hierarchical analysis method and the competency characteristics stratification in the competency model, the hierarchy of the evaluation indexes of skilled talents in oil and gas enterprises is determined as a three-level structural model, with the top level being the objective level M, i.e. the evaluation of the competency index system of skilled talents, the bottom level being the indicator level, i.e. the 20 influencing factors (B11~B44), and the middle being the criterion level A, which includes 4 levels of indicators, namely, Knowledge and Skills A1, Personality Traits A2, Work Motivation and Values A3, and Personal Management A4. A2, work motivation and values A3, and personal management A4, a total of 4 level 1 indicators. The hierarchical structure of the evaluation index set of oil and gas enterprises' technological type is shown in Figure 1[7].

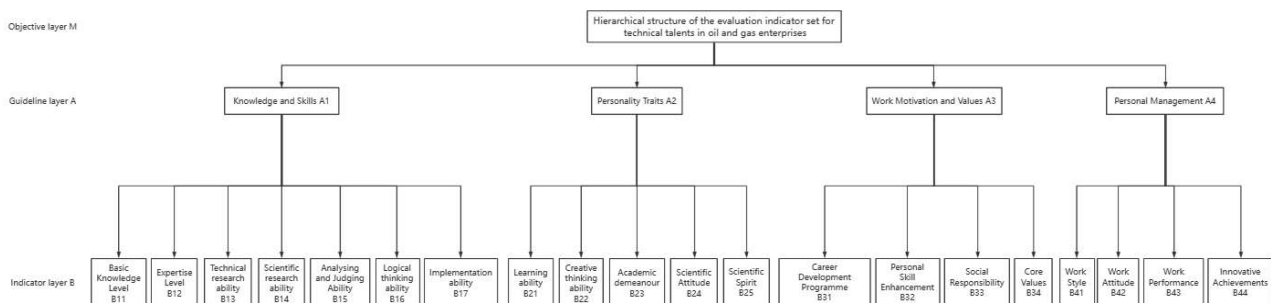


Figure 1. Hierarchical structure of the evaluation index set of technical talents in drilling and mining institute

2.2.2. Constructing Judgement Matrices and Performing Consistency Tests

Step 1: Adopting the Delphi method, regarding the indicators of the competence system of skilled personnel, adopting the 1-9 scale method, the scale table is shown in Table 2, designing relevant questionnaires, inviting experts and scholars and so on to analyse the weights of the evaluation indicators of all levels, and making judgement assignments on the degree of

influence of the criterion layer (B) on the target layer (M) and the programme layer (B) on the criterion layer layer (A), respectively.

Table 2. 1-9 Correspondence table for the scale method

scale	instructions
1	Factor <i>i</i> is equally important compared to factor <i>j</i>
3	Factor <i>i</i> is slightly more important than factor <i>j</i>
5	Importance of factor <i>i</i> compared to factor <i>j</i>
7	Factor <i>i</i> is very important compared to factor <i>j</i>
9	Absolute importance of factor <i>i</i> compared to factor <i>j</i>
2,4,6,8	Indicates a level of importance between 1 and 3, 3 and 5, 5 and 7, 7 and 9.
	The judgement of factor <i>i</i> compared to factor <i>j</i> is a_{ij} , then the judgement of factor <i>j</i> compared to factor <i>i</i> is $a_{ji} = \frac{1}{a_{ij}}$ inverse

Step 2: Construct the judgement matrix.

(1) Construct the criterion level/target level A-M judgement matrix ($A_i \rightarrow M$)

Compare the importance of the *i*th element of the guideline layer with the *j*th element for the target layer. According to the statistical results of the collected questionnaires from experts and scholars, the importance measure of the *i*th element relative to the *j*th element is obtained a_{ij} , forming a judgement matrix.

(2) Construct the programme level/criteria level B-A judgement matrix ($B_{ij} \rightarrow A_i$ ($i=1, 2...4; j=1, 2...7$))

$B_{1j} \rightarrow A_1$ ($j=1, 2...7$) (B_{1j} Judgement matrix of programme layers relative to knowledge and skills).

$B_{2j} \rightarrow A_2$ ($j=1, 2...5$) (B_{2j} Judgement matrix of programme levels relative to personality traits).

$B_{3j} \rightarrow A_3$ ($j=1, 2...4$) (B_{3j} Programme level judgement matrix relative to work motivation and values).

$B_{4j} \rightarrow A_4$ ($j=1, 2...4$) (B_{4j} Judgement matrix for programme level versus individual management)

Step 3: Matlab for consistency test.

According to the formulas $CI = \frac{\lambda_{max} - n}{n - 1}$, $CR = \frac{CI}{RI}$, the data of each judgement matrix is entered in

Matlab and consistency test is carried out, CR less than 0.1 passes the consistency test, and finally all of them pass the consistency test. [8]The judgement matrices and tests are shown in Table 3-Table 7.

Table 3. Calculation of weights and consistency test table for indicators at the level of skilled personnel

synthesis	Indicator 1	Indicator 2	Indicator 3	Indicator 4	multiply by rows	Open n times.	Weight W_i	AWi	AWi/ W_i	characteristic root	CI	RI	CR
Indicator 1	1	2	7	5	70.000	2.893	0.54	2.165	4.002	4.042	0.014	0.900	0.015
Indicator 2	1/2	1	3	3	4.500	1.456	0.27	1.102	4.047				
Indicator 3	1/7	1/3	1	1/2	0.024	0.393	0.07	0.298	4.057				
Indicator 4	1/5	1/3	2	1	0.133	0.604	0.12	0.459	4.061				
Subtotal						5.346			16.167	CR<0.1, passes the test			

(of which Indicator 1: Knowledge and Skills; Indicator 2: Personality Traits; Indicator 3: Work Motivation and Values; Indicator 4: Personal Management).

Table 4. Indicator weights and consistency test of knowledge and skill dimensions of technical talents

	Indicator 1	Indicator 2	Indicator 3	Indicator 4	Indicator 5	Indicator 6	Indicator 7	multiply by rows	Open times.	Weight Wi	A Wi	AWi/Wi	characteristic root	CI	RI	CR
Indicator 1	1	1/5	1/5	1	1/2	1	2	0.040	0.631	0.07	0.463	7.016	7.027	0.005	1.32	0.003
Indicator 2	5	1	1	5	3	5	7	2625	3.079	0.32	2.261	7.024				
Indicator 3	5	1	1	5	3	5	7	2625	3.079	0.32	2.261	7.024				
Indicator 4	1	1/5	1/5	1	1/2	1	2	0.040	0.631	0.07	0.463	7.016				
Indicator 5	2	1/3	1/3	2	1	2	3	2.667	1.150	0.12	0.845	7.027				
Indicator 6	1	1/5	1/5	1	1/2	1	2	0.040	0.631	0.07	0.463	7.016				
Indicator 7	1/2	1/7	1/7	1/2	1/3	1/2	1	0.001	0.364	0.03	0.269	7.069				
Subtotal									9.567			49.191		CR<0.1, passes the test		

(of which Indicator 1: Basic knowledge; Indicator 2: Expertise; Indicator 3: Technical research capacity; Indicator 4: Scientific research capacity; Indicator 5: Analytical and judgemental capacity; Indicator 6: Logical thinking capacity; and Indicator 7: Follow-up and implementation capacity).

Table 5. Indicator weights and consistency test of personality trait dimensions of technical talents

	Indicator 1	Indicator 2	Indicator 3	Indicator 4	Indicator 5	multiply by rows	Open times.	Weight Wi	A Wi	AWi/Wi	characteristic root	CI	RI	CR
Indicator 1	1	2	2	5	5	100	2.512	0.40	2.047	5.011	5.005	0.001	1.12	0.001
Indicator 2	1/2	1	1	3	3	4.500	1.351	0.22	1.100	5.004				
Indicator 3	1/2	1	1	3	3	4.500	1.351	0.22	1.100	5.004				
Indicator 4	1/5	1/3	1/3	1	1	0.022	0.467	0.08	0.380	5.004				
Indicator 5	1/5	1/3	1/3	1	1	0.022	0.467	0.08	0.380	5.004				
summation (math)							6.148			25.027		CR<0.1, passes the test		

(of which Indicator 1: Learning ability; Indicator 2: Ability to think creatively; Indicator 3: Academic demeanour; Indicator 4: Attitude towards science; Indicator 5: Scientific spirit).

Table 6. Indicator weights and consistency test of technical personnel's work motivation and value dimensions

	Indica tor 1	Indica tor 2	Indica tor 3	Indica tor 4	multi ply by rows	Ope n n tim es.	Wei ght Wi	AW i	AWi/ Wi	characte ristic root	CI	RI	CR
Indicat or 1	1	1/5	1/2	1/5	0.020	0.3 76	0.08	0.3 01	4.00 6	4.004	0.0 01	0.9 00	0.0 02
Indicat or 2	5	1	3	1	15.00 0	1.9 68	0.39	1.5 76	4.00 2				
Indicat or 3	2	1/3	1	1/3	0.222	0.6 87	0.14	0.5 50	4.00 6				
Indicat or 4	5	1	3	1	15.00 0	1.9 68	0.39	1.5 76	4.00 2				
summa tion						4.9 99			16.0 17		CR<0.1, passes the test		

(of which Indicator 1: Career Development Plan; Indicator 2: Personal Skills Upgrading; Indicator 3: Social Responsibility; Indicator 4: Core Values).

Table 7. Indicator weights and consistency test of technical talents' personal management dimension

	Indica tor 1	Indica tor 2	Indica tor 3	Indica tor 4	multi ply by rows	Ope n n tim es.	Wei ght Wi	AW i	AWi/ Wi	characte ristic root	CI	RI	CR
Indicat or 1	1	1	5	3	15.00 0	1.9 68	0.39	1.5 76	4.00 2	4.004	0.0 01	0.9 00	0.0 02
Indicat or 2	1	1	5	3	15.00 0	1.9 68	0.39	1.5 76	4.00 2				
Indicat or 3	1/5	1/5	1	1/2	0.020	0.3 76	0.08	0.3 01	4.00 6				
Indicat or 4	1/3	1/3	2	1	0.222	0.6 87	0.14	0.5 50	4.00 6				
summa tion (math)						4.9 99			16.0 17		CR<0.1, passes the test		

(of which Indicator 1: Work style; Indicator 2: Work attitude; Indicator 3: Work performance; Indicator 4: Innovative results).

Step 4: Calculate the weights.

Comparing the calculation results of the maximum characteristic root method, arithmetic mean method and geometric mean method, this paper adopts the maximum characteristic root method, with the help of Matlab software, the results of the recovered questionnaires are operated as above and the average value is calculated to get the results (Table 8).

Table 8. Weighting table of evaluation indicators for technical talents in oil and gas enterprises

Type of talent	weights	Level 1 indicators	weights	Secondary indicators	weights
skilled person	100	Knowledge and skills	54	basic level of knowledge	7
				level of expertise	32
				Technical research capacity	32
				Research capacity	7
				analytical and judgemental skills	12
				logical thinking	7
				Capacity for implementation	3
		trait	27	learning ability	40
				Creative thinking skills	22
				academic manner	22
				scientific attitude	8
				scientific spirit	8
		Work motivation and values	7	Career Development Programme	8
				Individual technical upgrading	39
				sense of social responsibility	14
				Core values	39
personal management	12	conduct	39		
		attitude	39		
		Work performance	8		
		Innovations	14		

2.3. Design of Criteria for Determining Evaluation Results

According to the evaluation object and evaluation content, we set the evaluation result as "Yes (talent)" and "No (non-talent)", and the correspondence between each grade and the calculation result is shown in Table 9.

Table 9. Range of Talent Evaluation Criteria Levels

Evaluation results	Suggested range
be	[90,100]
clogged	[0,90)

2.4. Design of Calculation of Evaluation Indicator Values

By carefully collating, analysing and summarising the literature on the calculation of the evaluation value of talent evaluation indicators, the ideas and methods for calculating the evaluation value were determined.

The general calculation idea is to determine the scores for each secondary indicator under the four dimensions according to the application scenarios by the corresponding personnel through scoring, and then combine the constructed evaluation model with the calculation of each primary indicator according to the designed calculation method, and finally sum up to arrive at the assessment value of technical talents.

The values assigned to each level 2 indicator are obtained by direct scoring by the relevant personnel, so only the calculation method for each level 1 indicator needs to be designed.

1) Knowledge and skills (Knowledge) indicator evaluation value calculation methodology

$$\text{Knowledge and Skill } \bar{K} = \sum_{i=1}^5 Q_i \times \bar{W}_{K_i}$$

where \bar{K} represents the value of the knowledge and skills indicator rating, and K_i represents the individual indicators under the knowledge and skills indicator dimension, the \bar{W}_{K_i} represents the structural weight of the indicator K_i the structural weights of the indicators.

2) Calculation of the evaluation value of personality traits (Speciality) indicators

$$\text{Personality Traits } \bar{S} = \sum_{i=1}^9 S_i \times \bar{W}_{S_i}$$

In the formula. \bar{S} represents the personality trait evaluation value, and S_i represents the indicators under the personality trait indicator dimension, and \bar{W}_{S_i} represents the weights of the indicators S_i weights of the indicators.

3) Method of calculating the evaluation value of the Motivation and Values (Motivation) indicator.

$$\text{Work Motivation and Values } \bar{M} = \sum_{i=1}^4 M_i \times \bar{W}_{M_i}$$

In the formula. \bar{M} represents the value of work motivation and values assessment, and M_i represents the indicators under the Work Motivation and Values indicator dimension, and \bar{W}_{M_i} represents the weights of the indicators M_i weights of the indicators.

4) Calculation of the value of the Personal Management indicator

$$\text{Personal Management } \bar{P} = \sum_{i=1}^5 P_i \times \bar{W}_{P_i}$$

In the formula \bar{P} represents the personal management evaluation value, and P_i represents the individual indicators under the personal management indicator dimension, and \bar{W}_{P_i} represents the weights of the indicators P_i weights of the indicators.

The results calculated in accordance with the method of calculating the evaluation value of the first-level evaluation indicator can be used to evaluate the competence level of technical personnel in each dimension.

According to the evaluation index system of technical talents constructed earlier, the formula for calculating the evaluation value of technical talents' competence can be derived as follows:

$$\bar{O} = \sum_{i=1}^4 \bar{A}_i \times \bar{W}_{A_i}$$

included among these $\bar{A}_i = \sum_{j=1}^n A_{ij} \times \bar{W}_{A_{ij}}$.

In the formula \bar{O} represents the talent competency assessment value; \bar{A}_i represents the evaluation value of the first-level indicator, and \bar{W}_{A_i} represents the evaluation value of the first-level indicator, and A_{ij} represents the evaluation value of the second-level indicator. $\bar{W}_{A_{ij}}$ represents the weight of the second-level indicator.

The results calculated in accordance with the method of calculating the competency evaluation value of technical personnel can be used to evaluate the competency level of technical personnel and, in conjunction with the corresponding evaluation criteria, to judge whether or not the subject of the evaluation is a technical personnel.

3. Conclusion

In the context of the new era, higher requirements are put forward for enterprises, and talent resources are the most important for the high-quality development of enterprises. Innovative thinking to do a good job of enterprise talent evaluation work, for enterprise talent screening, talent training, talent appointment and talent management play a key role. Through scientific planning, rational layout, policy support, strengthen incentives, strengthen the talent work and business work through and linkage, to achieve the talent chain, innovation chain, industrial chain, value chain integration and development, for the implementation of the enterprise development strategy to provide strong support for talent.

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