# The Research on The Comprehensive Evaluation Method of Electronic Countermeasure Talents' Ability and Quality

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**Abstract:** In order to evaluate the ability and quality of electronic countermeasures talents scientifically and accurately, Firstly, we describe the comprehensive evaluation method of talents' ability and quality with multiple strategies in general, then we analyze and verify the evaluation method item by item according to an example, it proves that the comprehensive evaluation method is feasible. The research shows that the combination of subjective evaluation, fuzzy theory, data mining and other multidisciplinary evaluation methods can achieve a more optimized evaluation effect, it can complete the comprehensive evaluation of the ability and quality of the actual electronic countermeasures troops.

**Key words:** Electronic countermeasures talents, ability and quality evaluation, fuzzy comprehensive evaluation, BP neural network

## 1. Introduction

Electronic countermeasure force is a new combat force, and electronic countermeasure talents are important factors to win modern information war. The ability quality and function of the talent team will directly determine the success or failure of the struggle in the electromagnetic field, and then affect the outcome of the war. talents evaluation for electronic countermeasures is the basis and key to the selection, appointment and training of talents for electronic countermeasures. Due to the influence of subjective evaluation in the actual evaluation process, evaluation indexes are not quantified and systematic methods are not formed, which is easy to cause the deviation and missteps of talent evaluation. Therefore, it is necessary to study and explore the method system suitable for the comprehensive evaluation of the ability and quality of electronic countermeasures talents.

## 2. Comprehensive evaluation method

The electronic countermeasures talents are a special group of personnel who can master the basic operation mechanism of electromagnetic space, be familiar with the characteristics and laws of electronic countermeasures, proficient in the use of electronic countermeasures methods, and can make a difference in the execution of tasks [1]. As the typical representative of new quality fighting ability, such group has high cultural level, strong business skills,

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excellent comprehensive quality, and is a talent with high wisdom, high skills and high creativity. The evaluation of such talent group is an all-round, multi-objective and multi-level evaluation problem. In this paper, an evaluation method based on BP neural network will be constructed, which will be applied to the evaluation of electronic countermeasures talents. Firstly, the analytic hierarchy process (AHP) method and fuzzy comprehensive evaluation are used to quantitatively evaluate the electronic countermeasures talents. The AHP method is used to solve the weight judgment problem that is difficult to be described quantitatively. The fuzzy comprehensive evaluation method is used to quantify the experience knowledge and judgment characteristics of the evaluators, and the evaluation grade results are obtained through calculation. Through BP neural network modeling, the indicator scores and evaluation grade results are used as training sample set to train the network, and a certain system error is set to obtain a high-precision learning network. Then the simulation sample set is used to test the learning network. The trained evaluation method based on BP neural network can be used as an evaluation tool to make more scientific and reasonable evaluations for other personnel objects besides the training sample set [2]. The structure of the evaluation method is shown in Fig. 1.

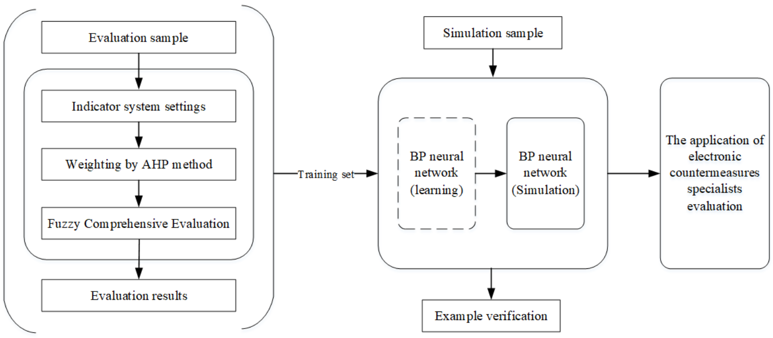


**Fig. 1** The structure chart of electronic countermeasures talents evaluation method

## 3. Evaluation indicator system

In order to verify the feasibility of the evaluation method, this paper takes the personnel of a professional electronic countermeasures unit of the Air Force as an example. We want to evaluate the ability and quality of talents by using the above evaluation method. Firstly, According to the characteristics of the electronic countermeasures talents, it is necessary to focus on the core military capabilities of electronic countermeasures, and on the basis of expert consultation, BEI (behavioral event interviews) and questionnaires, determine the characteristic indicators, divide the system dimensions, and then construct the ability and quality evaluation system of electronic countermeasures talents. The indicator system includes the target layer, the criterion layer and the indicator layer. The target layer is a comprehensive evaluation of electronic countermeasures talents. The criterion layer is a sub-item evaluation of knowledge elements, ability elements, quality elements and experience elements (4 first-level indicators). The indicator layer is a specific description of the project content contained in each element (18 second-level indicators) [3]. as shown in Fig. 2.

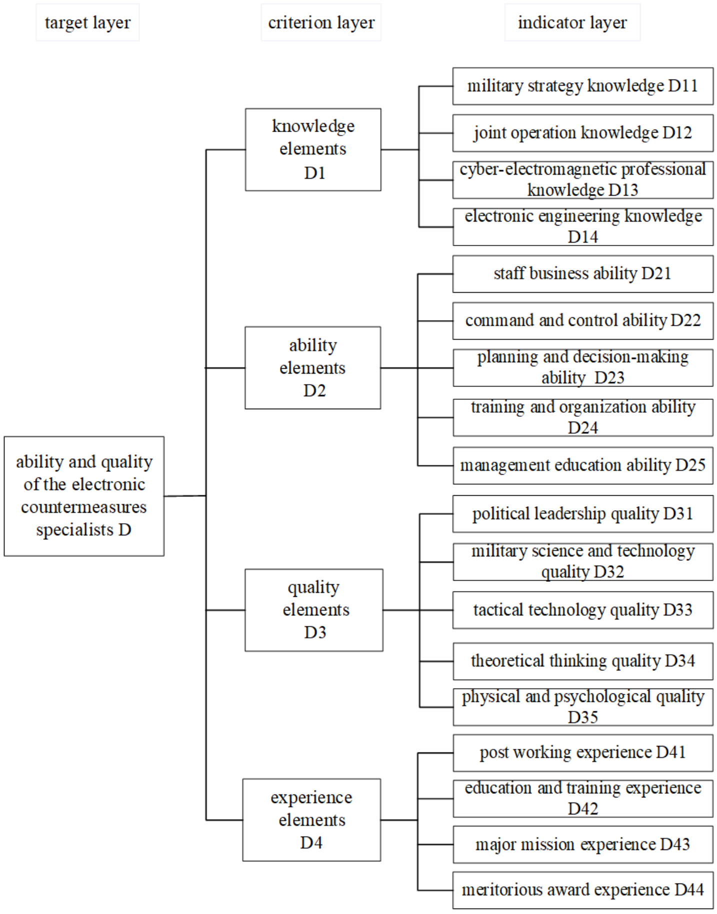


**Fig. 2** The indicator system of electronic countermeasures talents evaluation

## 4. Weighting by AHP method

Construct the ability and quality evaluation indicator set D, $D=\{D_1,D_2,\cdots,D_m\}$, where m represents the number of first-level indicators, and n represents the number of second-level indicators under the first-level indicators $D_i$. The AHP method is adopted to compare the indicators at the same level in pairs according to the 9-scale method, and the judgment matrix is constructed and normalized to obtain $A^{'}=\left[a_{ij}^{'}\right]_{m\times n}$, and then calculate the feature vector W of the judgment matrix $A^{'}$ [4]:

$$W = \{W_1, W_2, \cdots, W_m\}, W_i = \frac{1}{n}\sum_{j=1}^{n} \overline{a}_{ij} \tag{1}$$

The maximum characteristic root $\lambda_{max}$, consistency indicator $CI$ and consistency ratio $CR$ of the judgment matrix $A'$ are calculated by consistency test. If $CR < 0.1$, the judgment matrix meets the consistency requirements, otherwise, readjust the matrix. Through the above calculation, the weight vector of the first-level indicator $A$ and the weight vector of the second-level index $A_i$ are finally obtained [4]:

$$A = \{A_1, A_2, ..., A_m\}, \sum_{i=1}^{m} A_i = 1, A_i \geq 0 \text{ ; } A_i = \{a_{i1}, a_{i2}, ..., a_{in}\}, \sum_{j=1}^{n} a_{ij} = 1, a_{ij} \geq 0 \tag{2}$$

Taking the commanding officer of a key post in the air Force electronic countermeasures professional unit as an evaluation example, the analytic hierarchy process is adopted to calculate the weights of indicators at all levels, and the following results can be obtained after consistency test:

$A = (0.25, 0.30, 0.24, 0.21)$

$A_1 = (0.12, 0.15, 0.45, 0.28)$, $A_2 = (0.13, 0.39, 0.25, 0.13, 0.10)$

$A_3 = (0.29, 0.15, 0.24, 0.10, 0.22)$, $A_4 = (0.18, 0.24, 0.24, 0.34)$

## 5. Fuzzy comprehensive evaluation

Establish an evaluation set of electronic countermeasures talents $V = \{V_1, V_2, V_3, V_4\}$ = {excellent, good, average, poor}. To achieve quantification, a percentage system evaluation set is used $V'$:

$$V' = \left\{ \frac{100 - 90}{excellent}, \frac{90 - 75}{good}, \frac{75 - 60}{general}, \frac{60 - 45}{range} \right\} \tag{3}$$

For the fuzzy evaluation of single-level indicators, the F statistical method (affiliated to frequency method) is adopted to determine the fuzzy relationship, that is, the evaluators or experts evaluate and score the indicators, and through the statistical scoring results, calculate the membership degree $r'_{ij}$ of the underlying single-factor indicators corresponding to each evaluation in the evaluation set. $r_{ij}^{'} = (r_1^{'}, r_2^{'}, r_3^{'}, r_4^{'})$, $r_k^{'} = x_{ij} / N$ . where $r_{ij}^{'}$ is the membership degree of a single indicator corresponding to different levels $V_k (k = 1, 2, 3, 4)$ in the evaluation set V, N is the number of experts, and $x_{ij}$ is the number of times the indicator $\mathrm{d}_{ij}$ is evaluated to be $V_k (k = 1, 2, 3, 4)$ [5]. Considering the weight distribution under the condition of two-layer indicators, the fuzzy comprehensive evaluation decision-making method is:

$$C = A * B = A * \begin{pmatrix} B_1 \\ B_2 \\ \cdots \\ B_m \end{pmatrix} = A * \begin{pmatrix} A_1 * R_1 \\ A_2 * R_2 \\ \cdots \\ A_m * R_m \end{pmatrix} \tag{4}$$

where $R_i$ is the membership degree of the second-level indicator $d_{ij} (j = 1, 2, ..., n)$ under the first-level indicator to the evaluation set V. According to the characteristics of the method and matrix operation mode, it can also be obtained that:

$$C = A * B = A_1 * B_1 + A_2 * B_2 + ... + A_m * B_m ; \quad B_i = A_i * R_i = a_{i1} * r_{i1} + a_{i2} * r_{i2} + ... + a_{in} * r_{in} \tag{5}$$

According to the above results and data, the evaluation results of the sub-element comprehensive evaluation result $E_i$ and the overall comprehensive evaluation result $E$ of the ability and quality evaluation system of the electronic countermeasures talents can be calculated[5]:

$$E_i = B_i * V'^T = A_i * R_i * V'^T ; \quad E = C * V'^T = A * (E_1, E_2, E_3, E_4)^T \tag{6}$$

It is determined that a total of 10 people in the evaluation team organize the evaluation, and the F-statistic method is used to determine the fuzzy evaluation matrix and perform weighted synthesis, there are:

$$R_1 = \begin{pmatrix} 0.20 & 0.35 & 0.45 & 0 \\ 0.32 & 0.56 & 0.12 & 0 \\ 0.25 & 0.35 & 0.40 & 0 \\ 0.10 & 0.55 & 0.35 & 0 \end{pmatrix}, \quad R_2 = \begin{pmatrix} 0.39 & 0.26 & 0.35 & 0 \\ 0.24 & 0.35 & 0.41 & 0 \\ 0 & 0.42 & 0.58 & 0 \\ 0.15 & 0.55 & 0.30 & 0 \\ 0.28 & 0.45 & 0.27 & 0 \end{pmatrix}$$

$$R_3 = \begin{pmatrix} 0.15 & 0.45 & 0.40 & 0 \\ 0.12 & 0.45 & 0.43 & 0 \\ 0.30 & 0.42 & 0.28 & 0 \\ 0.25 & 0.55 & 0.20 & 0 \\ 0.24 & 0.50 & 0.26 & 0 \end{pmatrix}, \quad R_4 = \begin{pmatrix} 0.42 & 0.45 & 0.13 & 0 \\ 0.25 & 0.58 & 0.17 & 0 \\ 0.16 & 0.44 & 0.40 & 0 \\ 0.28 & 0.32 & 0.40 & 0 \end{pmatrix}$$

According to the existing data, combined with the comprehensive fuzzy evaluation method, it can be calculated as:

$$B_1 = A_1 * R_1 = (0.21, 0.44, 0.35, 0), \quad B_2 = A_2 * R_2 = (0.19, 0.39, 0.42, 0)$$

$$B_3 = A_3 * R_3 = (0.21, 0.46, 0.33, 0), \quad B_4 = A_4 * R_4 = (0.27, 0.44, 0.30, 0)$$

$$E_1 = B_1 * V'^T = 84.73, \quad E_2 = B_2 * V'^T = 83.71$$

$$E_3 = B_3 * V'^T = 85.61 \quad E_4 = B_4 * V'^T = 87.04$$

$$E = A * (E_1, E_2, E_3, E_4)^T = 0.25 * 84.73 + 0.30 * 83.71 + 0.24 * 85.61 + 0.21 * 87.04 = 85.12$$

It can be seen from the calculation results that the evaluation score of the commanding officer in a certain key post is 85.12, and the comprehensive evaluation is good.

## 6. BP neural network evaluation

For the evaluation of the ability and quality of electronic countermeasures talents, a three -layer BP neural network is established on the basis of the AHP-fuzzy comprehensive evaluation method. The number of neurons (nodes) in the input layer is set to x, corresponding to the basic indicator data D of the specialist ability and quality method, and the input layer vector is expressed as $D \in R^x, D = (d_1, d_2, \cdots, d_x)^T$. The number of neurons in the output layer is set to y, corresponding to the evaluation result E of the specialist ability and quality system and the output layer vector is expressed as $E \in R^y, E = (e_1, e_2, \cdots, e_y)^T$. The number of neurons in the hidden layer is set as z, the hidden layer vector is expressed as $F \in R^z, F = (f_1, f_2, \cdots, f_z)^T$ , $z = \sqrt{x + y} + g$ , and g is a constant between 1-10. Take (D,

E) as the teacher value of training BP neural network, specifically, the successful evaluation results of the AHP method and the fuzzy comprehensive evaluation are used as the training sample set of the BP neural network, and then the characteristics of such problems and the knowledge of expert evaluation are stored in the neural network weights. The trained BP neural network can be used to make comprehensive evaluation to evaluation object system and reproduce the experience and knowledge of evaluation experts [6-7].

The evaluation result data of the electronic countermeasures professional unit personnel (200 people) of the Air force were taken as the training sample to train the BP neural network. The training data set, validation data set, and test data set were respectively 65%, 20% and 15% of the total number, and the quantized conjugate gradient method was adopted as the algorithm for training the BP neural network. After repeated training, the number of neurons in the hidden layer was set to 15, and the fitting degree is good. It can be seen from Fig. 3 that after 86 iterations, the BP neural network tends to be stable, and the mean square error value is about 0.01.

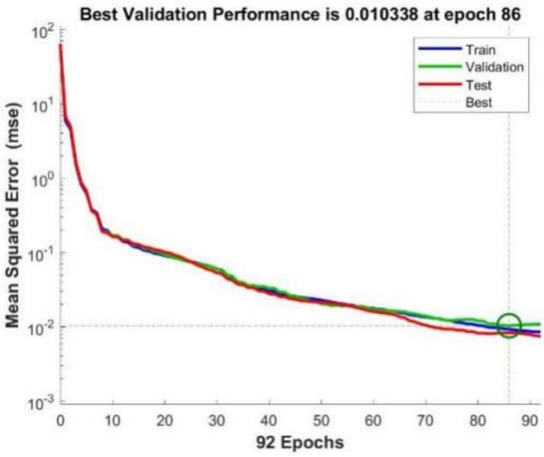


**Fig. 3** The iterations of training neural networks

In Fig. 4, the regression value R represents the correlation between the predicted output and the target output. The closer the R value is to 1, the closer the relationship between the predicted and output data is, and the closer the R value is to 0, the greater the randomness of the relationship between prediction and output data. The greater the sex. It can be seen from the Fig. that the trained BP neural network has good effect and can be used to comprehensively evaluate the ability and quality of electronic countermeasures talents.

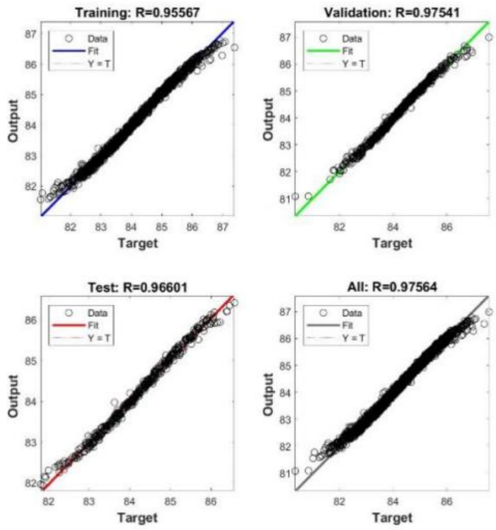


**Fig. 4** The fitting degree of training, validation, testing and overall data set

Then, the evaluation data of 10 people from the l electronic countermeasures professional unit of the Air force were selected as the simulation sample set, and the trained BP neural network was used for retrospective inspection. It can be seen from Fig. 5 that the errors between the output value E (measured) and the actual value E are within ±2%, and the evaluation results are highly consistent with the fuzzy comprehensive evaluation results given by the evaluation team, which proves that the evaluation method based on BP neural network is feasible and can complete the comprehensive evaluation of the ability and quality of the talents in the actual electronic countermeasures troops.

| | person 1 | person 2 | person 3 | person 4 | person 5 | person 6 | person 7 | person 8 | person 9 | person 10 |
|---|---|---|---|---|---|---|---|---|---|---|
| Actual | 84 | 74.6 | 81.3 | 76.8 | 83 | 82.8 | 77.2 | 82.2 | 67.4 | 78 |
| Output(predict) | 84.90 | 75.20 | 80.39 | 77.95 | 82.49 | 81.99 | 77.23 | 83.43 | 66.42 | 78.77 |
| Error | 1.08% | 0.80% | -1.12% | 1.49% | -0.61% | -0.97% | 0.04% | 1.49% | -1.46% | 0.99% |

**Fig. 5** The comparison of simulation results of BP neural networks evaluate

## 7. Conclusion

The research shows that the application of BP neural network in the process of electronic countermeasures talents evaluation can achieve good evaluation results. It not only can use the adaptability of network reasonably adjust the indicator weight, but also can eliminate some indicator deviation impact of qualitative analysis and subjective evaluation. The evaluation method is more scientific, the evaluation process is faster, and the evaluation results are more accurate, which provides a new idea and tool for the evaluation of electronic countermeasures talents. According to the applied evaluation method and the obtained evaluation results of the BP neural network evaluation method, it has certain guiding significance for the selection, appointment and training of talents in the actual electronic countermeasures troops.

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