Research on Evaluation of Equipment Supporting Equipment Support Ability Based on BP-Neural Network

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Keywords: remedial installation, neural network

Abstract: The equipment maintenance capability of military-civilian integration enterprise is an important part of the development of military-civilian integration equipment. This paper mainly focuses on the evaluation of equipment maintenance equipment support capability of military-civilian integration enterprises, and constructs corresponding index system and evaluation model. On this basis, the expert system is used to generate sample data to train the neural network, and some sample data is used to test the evaluation model. The feasibility of the evaluation system is verified by comparing the mean square error between the sample data and the evaluation data.

1. Introduction

With the deepening of the national strategy of military-civilian integration, civil technology is deeply involved in the development of equipment and equipment through diversified means, effectively making up for the increasingly complex structure of informationized weapons and equipment, while the scale of the military is shrinking and the task of equipment support is becoming more and more The heavy contradiction that is cumbersome and the difficulty of protection continues to increase. In the field of equipment maintenance equipment, the military-civilian integration guarantee mode enables local security resources, technology and other factors to fully penetrate into the business activities of all aspects of equipment support, and hand over some non-core equipment support services to the localities to ensure their own core business. The completion of the project, through the integration of optimization of the military and civilian security resources, to meet the needs of equipment maintenance and support work to meet the military and economic benefits of the military. At present, civil advanced technology has been deeply integrated into the field of military equipment support. However, how to effectively and accurately assess the equipment maintenance capability of military-civilian integration enterprises, comprehensively and accurately understand the level and status quo of its support capacity building, and safeguard the military-civilian integration enterprise for the military. Capacity building is of great significance. Based on the establishment of equipment maintenance equipment support capability evaluation index system, this paper uses neural network algorithm to evaluate the equipment support ability [1].

2. Establishment of the indicator system

2.1 Evaluation index selection

The construction of the support capability assessment indicator system is the basis and core of the capacity assessment work [2]. For the construction of military and civilian integration enterprise equipment maintenance equipment support capacity, it is necessary to fully integrate the various elements involved in equipment support, including the equipment storage and supply capacity of military-civilian integration enterprises, and the quality of personnel. Establish technical standards, rules and regulations, management norms for military and civilian integration enterprise equipment maintenance equipment support, realize the integration of information technology flow, material flow, personnel flow and other aspects of military and civilian integration enterprise equipment support, and continuously improve the equipment support capability of military-civilian integration enterprises.

The equipment support ability depends not only on the hard indicators such as the type of equipment, the scale of storage and supply, but also the soft indicators of talent quality and delivery ability. From the perspective of military-civilian integration enterprises, the article combines the basic characteristics and requirements of maintenance equipment support, from the number of personnel personnel F1, equipment storage and supply force F2, handling capacity F3, distribution capacity F4, information technology level F5, distribution capacity F6, service Capacity F77 first-level indicators, 19 second-level indicators, as shown in Figure 1, the initial screening of equipment support capacity indicators.

2.2 Analysis of evaluation indicators

2.2.1 Number of personnel in the enterprise F1 [3]

The number of military and civilian integration enterprises directly determines the level of support capability. The actual number of personnel in place and the professional level of the incumbent are the hard indicators that affect the equipment support capability. Insufficient number of people in place or low professionalism may lead to problems such as incorrect delivery, delay in delivery, and low efficiency. The average staff delay time is a measure of the average time each time the equipment support delay is completed. The indicator is mainly divided into three secondary indicators: the full staffing rate, the professional level of the salesman and the average staff delay time.

2.2.2 Equipment storage capacity F2

The storage and supply capacity of the equipment mainly reflects the ability of the enterprise to use the equipment to be protected. The integrity of the equipment directly determines the quality of the guarantee. The guarantee of the distribution equipment is low, which will inevitably affect the equipment support effect. The quality of the equipment directly reflects its guarantee ability. Therefore, this indicator mainly distinguishes the four secondary indicators of equipment integrity rate, equipment quantity satisfaction rate, equipment variety matching rate and equipment reserve rate.

2.2.3 Handling capacity F3

The handling capacity mainly evaluates the company's handling level and mode selection of the equipment it owns, and can use the efficient use of professional handling equipment and handling tools for rapid deployment and handling, mainly setting the transportation equipment matching rate and handling equipment integrity rate two levels index.

2.2.4 Distribution capacity F4

The distribution capability plays a decisive role in the equipment support capability of the enterprise. Whether the enterprise has the ability to deliver multiple means in a complex environment is an important indicator for examining the equipment support capability of the enterprise, including the transportation equipment matching rate and the transportation equipment integrity rate. And three modes of transportation mode of application.

2.2.5 Information Technology Level F5

With the complexity of equipment and the continuous advancement of management information, the level of information technology of enterprises directly affects the efficiency and accuracy of enterprise equipment support. The level of good information technology plays an important role in generating equipment support capability. The promotion role mainly includes two secondary indicators: database construction level and maintenance equipment informationization rate.

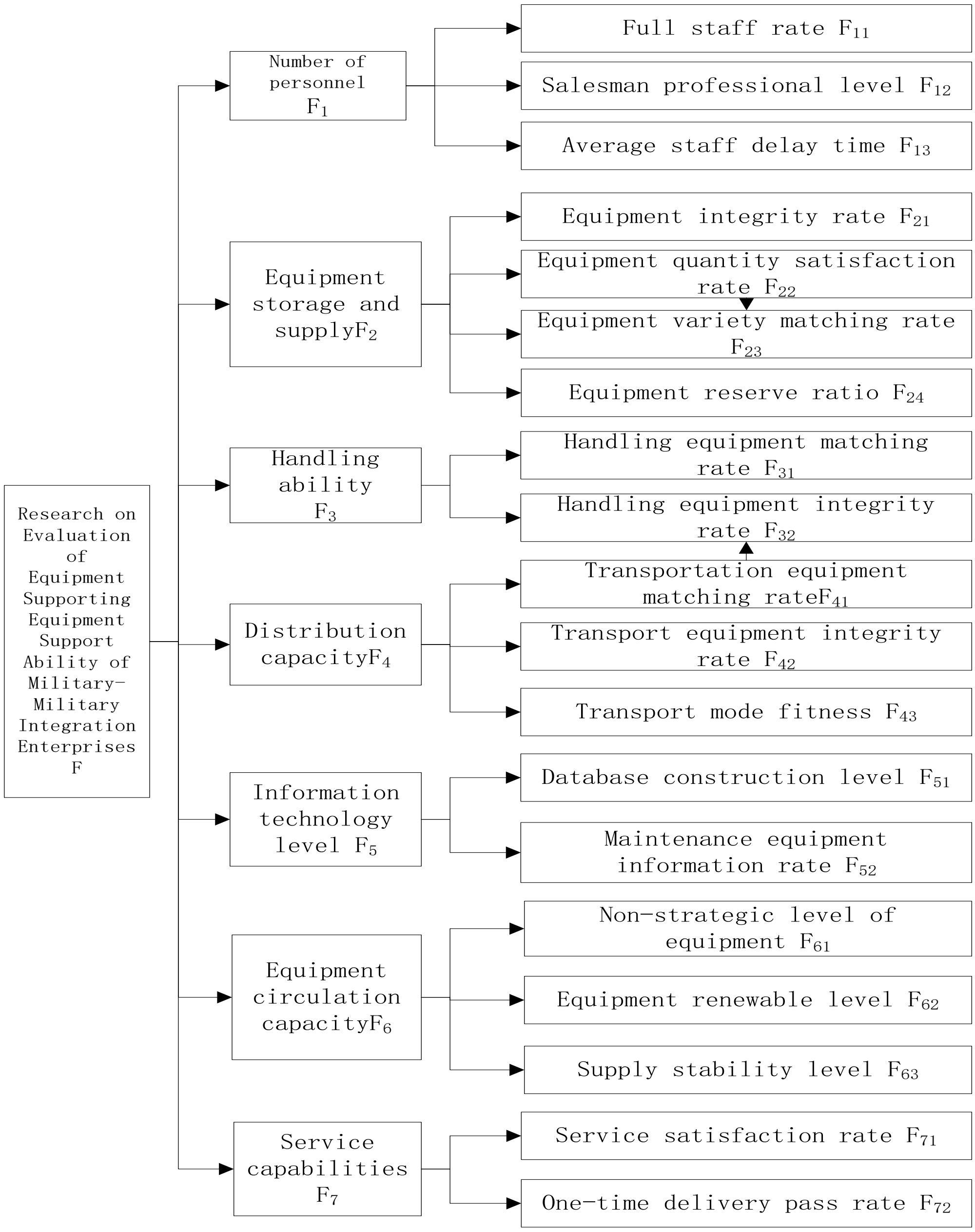

Figure 1. Indicator system

2.2.6 Equipment circulation capacity F6 [4]

The non-strategic level of resources reflects the low confidentiality and low value of the safeguard resources, and has little impact on the completion of the overall activities. The level of resource renewability reflects the sustainability of the resources for equipment support activities, that is, the rapid development rate. In terms of speed consumption characteristics, and the company has a relatively stable supply capacity. It mainly includes three secondary indicators: resource non-strategic level, resource renewability level and supply stability level.

2.2.7 Service Capability F7

Enterprise service capability is the basis for participating in the service quality of the force support business. If the local security department has strong service capabilities, it can not only ensure the quality and quantity to complete the support task, but also provide some auxiliary improvements and safeguard methods for the troops. The optimization of the program will promote and promote the equipment support capability of the military. It mainly includes two secondary indicators: service satisfaction rate and one-time delivery qualification rate.

2.3 Quantification of evaluation indicators

The impact of the indicator system on the capability assessment has two aspects: quantitative impact and qualitative impact. In order to ensure that the impact of each indicator on the capability assessment is consistent, the indicator needs to be quantified. Mainly through the following three steps to achieve:

Step1 Consulting experts (Z1, Z2…,Zm,) quantize the indicators (I_1, I_2, I_3…Ij), then Zi (i=1,2,3, …,m) The influence of an expert on the index Ij (j=1,2,3, …,n) is recorded as M_{ij}.

Step2 According to the scoring situation of each expert, calculate the total impact of each indicator on the support ability, and define the total importance of the j-th indicator as

$$x_j = \sum_{i=1}^{m} M_{ij} \, (j = 1, 2, \cdots n) \tag{1}$$

Step3 Normalize the indicators for expert scoring:

$$x_j = \sum_{i=1}^{m} M_{ij} \, (j = 1, 2, \cdots n) \tag{2}$$

After processing, you can get the sorting vector of each indicator: s

3. Evaluation model and simulation

3.1 Collecting sample data

According to the evaluation index system, relevant experts will be organized to conduct in-depth research and understanding of military-civilian integration enterprises, and collect and collect the previous guarantees to ensure the authenticity and objectivity of the sample data. Generally, the equipment maintenance capability of military-civilian integration enterprises is divided into poor, poor, medium, good, and good grades. The corresponding scoring criteria are [0, 0.6), [0.6, 0.65), [0.65, 0.85), [0,85,0.9), [0.9,1] 5 intervals. According to the rating assessment, 25 sets of data were selected for analysis and processing.

3.2 Model construction

The article uses a three-layer BP neural network to evaluate the equipment capability index[5], and its network model is shown in Figure 1.

(1) Input layer. There are 19 input layer nodes of the neural network, which correspond to 19 secondary indicators in the evaluation index system, and the value interval is [0, 1].

(2) Implied layer. On the basis of satisfying the relationship between input and output, we should select fewer hidden layer nodes to make the network structure as simple as possible [6]. According to the empirical formula:

$$s = \sqrt{0.43mn + 0.12n^2 + 2.54m + 0.77n + 0.35} + 0.53$$

It can be found that the number of layers in the middle layer is rounded to n=8

(3) Output layer. The 19 secondary indicators are quantified and input into the neural network model. The comprehensive evaluation value of the equipment maintenance equipment support capability is obtained through the model output, and the value range is [0, 1] [7]. Therefore, the BP neural network model of 19-8-1 was adopted.

The transfer function uses "logsig", the training function selects "traingd", the learning function selects "traingd", the learning rate is 0.5, and the final allowable error of network training is set to 10^{-2}.

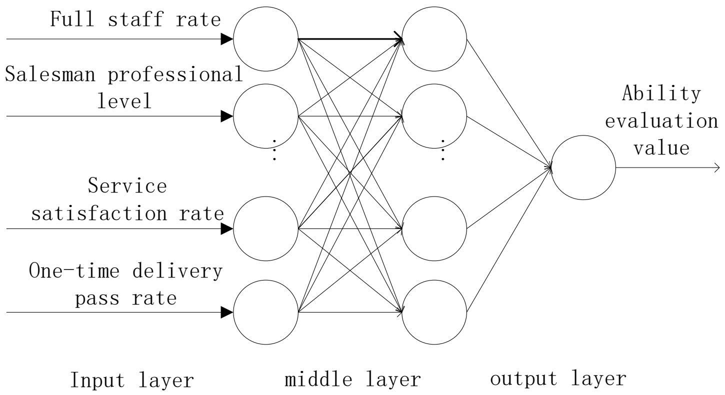

Figure 2 Neural network model

3.3 Training and simulation

In the BP neural network model of 19-8-1, 19 secondary indicator values are input, and the only guaranteed capacity value is output. 25 sets of data were selected as the initial sample data, wherein the first 20 sets of data were used as test sample data to train the network, and the last 5 sets of data were used as test sample data. The training data is input into the MATLAB neural network model. After repeated training, the parameters and the minimum error are continuously adjusted, and finally the trained model is obtained. The sample data is shown in Table1.

Table 1. Sample data

	F1	F2	F3	F4	F5	F6	…	F13	F14	F15	F16	F17	F18	F19	综合
Q1	0.76	0.81	0.88	0.88	0.88	0.89	…	0.76	0.78	0.74	0.79	0.76	0.89	0.87	0.83
Q2	0.76	0.74	0.72	0.71	0.71	0.71	…	0.71	0.78	0.87	0.83	0.82	0.74	0.83	0.76
Q3	0.77	0.79	0.76	0.83	0.73	0.75	…	0.78	0.81	0.69	0.73	0.73	0.71	0.69	0.77
Q4	0.48	0.57	0.58	0.40	0.58	0.34	…	0.70	0.55	0.60	0.63	0.55	0.38	0.60	0.52
Q5	0.54	0.75	0.64	0.79	0.59	0.71	…	0.67	0.69	0.51	0.64	0.57	0.76	0.62	0.63
Q6	0.76	0.72	0.86	0.76	0.87	0.90	…	0.82	0.78	0.83	0.75	0.87	0.77	0.87	0.81
Q7	0.78	0.63	0.77	0.72	0.78	0.66	…	0.72	0.71	0.74	0.79	0.72	0.61	0.72	0.70
Q8	0.40	0.42	0.43	0.43	0.37	0.40	…	0.37	0.37	0.42	0.43	0.38	0.39	0.35	0.39
Q9	0.80	0.86	0.80	0.87	0.73	0.84	…	0.79	0.86	0.88	0.76	0.84	0.83	0.80	0.82
⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮
Q11	0.59	0.35	0.57	0.37	0.48	0.51	…	0.57	0.46	0.51	0.53	0.43	0.58	0.43	0.48
Q19	0.78	0.73	0.70	0.73	0.75	0.78	…	0.69	0.60	0.73	0.64	0.61	0.66	0.75	0.70
Q20	0.41	0.49	0.36	0.48	0.37	0.40	…	0.45	0.47	0.35	0.49	0.46	0.36	0.42	0.43
Q21	0.86	0.81	0.89	0.83	0.76	0.84	…	0.76	0.87	0.81	0.82	0.89	0.80	0.77	0.82
Q22	0.65	0.56	0.60	0.68	0.50	0.54	…	0.58	0.70	0.52	0.56	0.67	0.69	0.55	0.59
Q23	0.67	0.80	0.63	0.68	0.74	0.68	…	0.74	0.77	0.71	0.65	0.75	0.74	0.79	0.71
Q24	0.47	0.44	0.37	0.48	0.50	0.47	…	0.42	0.42	0.39	0.48	0.34	0.45	0.47	0.43
Q25	0.82	0.88	0.94	0.84	0.94	0.86	…	0.80	0.81	0.86	0.89	0.89	0.82	0.94	0.87

Using the five sets of data from 21-25 to verify the evaluation model, the evaluation results obtained after inputting the model are shown in the second row shown in Table 2, and compared with the sample data, the error is within the allowable range.

Table 2. Comparison of sample values and evaluation values

	Q21	Q22	Q23	Q24	Q25
Sample value	0.82	0.59	0.71	0.43	0.87
Assessed value	0.8267	0.5881	0.7123	0.4283	0.8687
Absolute error	0.0067	0.0011	0.0023	0.0017	0.0013
Mean square error			0.0022		

4. Conclusion

With the continuous advancement of the national strategy of military-civilian integration, more and more military-civilian integration enterprises will be invested in the development of national defense construction, and the assessment of the support capability of equipment maintenance equipment is also an important guarantee for ensuring the healthy operation of equipment. This paper mainly explores the establishment of the indicator system, the establishment of the evaluation model and the verification of the operation. The next step can be further studied in terms of the close integration of the actual forces and the comprehensive consideration of various influencing factors.

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