Evaluation on Comprehensive Support Ability of Non-lethal Weapons in Sudden

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Abstract: In order to achieve a sudden assessment of non-lethal weapons in a comprehensive assessment of cross-regional capabilities, The comprehensive evaluation system of cross-regional comprehensive support capability including eight aspects is proposed, such as the readiness of combat readiness, the adequacy of resources, the guarantee of economy, the guarantee of timeliness, the guarantee of information, the guarantee of accuracy, the guarantee of flexibility and the rate of emergency support, Based on expert experience, eight kinds of guarantee schemes are quantitatively evaluated, A comprehensive evaluation model of cross-regional support capability was built by using the neural network toolbox embedded in MATLAB software, through the study and training of the sample data, the accuracy requirement of the prediction is achieved, and the network output and the expected value of the verification data also coincide well. The established evaluation model provides an effective means for the quantitative prediction of non-lethal weapon cross-regional comprehensive support capability.

1. Introduction

At present, China is in a special period of social transformation and economic transition. It is easy to cause mass incidents due to contradictions and conflicts. How to effectively deal with these mass incidents become the focus of attention of all sectors of society. In view of the "soft destruction, soft destruction", "humanitarian" and other unique advantages, non-lethal weapons to deal with various types of group emergencies of choice for equipment. Due to the vast territory of China, the storage of non-lethal weapons is also very scattered, when there is sudden mass incidents, relying only on the incident area of equipment reserves is difficult to effectively deal with complex situations of conflict, which need to mobilize the surrounding, and even within the whole of the non-lethal weapons, and therefore also related to non-lethal weapons integrated cross-regional security issues.

In dealing with sudden events, the use of non-lethal weapons of many types, models and complex, so the demand for non-lethal weapons needs of species diversity, the level of demand randomization and other characteristics. Non-lethal weapons global maneuver has the following characteristics: strong timeliness (emergency, time constraints, minimum maneuvering time is the primary goal); weak economy (pay more attention to military and social benefits, minimum maneuvering costs as a secondary goal); mode of transport (Non-lethal weapons in the number of needs, the type of demand, demand areas, transport (air, rail, road, waterway combined transport); a high degree of uncertainty (large-scale emergencies of the time, size and intensity can not be predicted, (From the designated manufacturers, versatility is poor, a wide range of financing channels narrow); protection of complex (to protect the professional, the standard requirements are high); poor of emergency equipment financing and replacement (by the designated manufacturers, versatility is poor, a wide range of financing channels narrow); protection of complex (protection of professional, high standards).

Equipment Support refers to the equipment in a state of combat readiness and can continue to complete the tasks required for the protection of the work, and equipment itself is closely related to the development of security issues[1]. In modern high-tech conditions of local wars, the equipment support has become another battle on the battlefield of modern battles, both sides even if the weapons and equipment are advanced, if not form the overall protection capabilities of equipment, can not win the war[2]. Equipment integrated security is not only consider the use of the protection of the economy and the adequacy of resources, while security issues forward to the equipment design and development stage, the equipment has "to protect, good security" congenital characteristics. Non-lethal weapon integrated protection of the main function is affordable life-cycle cost of equipment to meet the peace and security requirements. The ultimate goal is to improve the readiness of the equipment, mission success and sustained combat capability, reduce life cycle costs and special security needs[3].

Su Chang et al [4] established an overall model to evaluate the effectiveness of the equipment support system, and on this basis put forward the evaluation of equipment support system performance index system to determine the weight of the indicators. Chen Chunliang et al [5]for the traditional transportation network optimization algorithm does not apply to non-war military operations vehicle equipment support, proposed based on genetic algorithms and Monte Carlo simulation of vehicle equipment transportation network optimization algorithm to improve the vehicle equipment to ensure the transport effect. Yang Jianhua [6] studied the large-scale equipment spare parts supply network faced with large-scale emergencies emergency spare parts scheduling problem, and constructed a network supply situation to deal with emergencies spare parts scheduling planning model. Fiedrich et al. [7] proposed an emergency resource allocation optimal scheduling model from the perspective of time and space, and verified the effectiveness of the model by an example. Shen [8]proposed a hybrid fuzzy clustering algorithm to solve the rescue phase emergency cluster and emergency material distribution. Zou Ming et al [6] studied the resource scheduling optimization problem of aeronautic equipment support by genetic algorithm, and combined the grid route optimization with the aviation equipment support, and established the appropriate aviation equipment support through network optimization, demand assessment and route optimization Resource scheduling reference model and dynamic resource scheduling implementation scheme. These studies have a positive impact on the comprehensive support effectiveness evaluation of non-lethal weapons in the aspects of safeguard assessment and index construction. However, the establishment of indicators lacks systematic consideration and it is difficult to obtain quantitative results for decision-making.

In this paper, an index system for assessment of non-lethal weapon cross-regional comprehensive support capability is proposed, which is quantitatively evaluated by BP neural network. It aims to provide decision support for different trans-regional safeguard schemes.

2. Non-lethal Weapon Comprehensive Support Effectiveness Evaluation Index System

2.1 Index system

In the case of non-lethal weapons, it is necessary to build a comprehensive support system based on structural integrity and complete elements of the support capability evaluation index system. Non-lethal weapons, the ultimate goal is to achieve comprehensive protection of equipment, combat readiness, mission success and sustained combat capability, so readiness is the need to consider the first target. Mission success and sustainability are based on operational readiness, so to simplify the index principle, without a separate index; Non-lethal weapons in the design and use of the stage, the protection of resources, such as human, financial, material and so on is sufficient and appropriate amount is the important influence factor of the level of security, so we can get the right amount of resources; To meet the life-cycle cost of equipment to meet the security requirements of wartime peace reflects the protection of the economic indicators; War, a variety of complex environments changing rapidly, how in the shortest possible time, in order to effectively protect the resources to protect the continued combat effectiveness of equipment is the decisive factor in the outcome of the war, so the guarantee must have a strong timeliness; In modern battlefield information oriented, information is very important for fighting for resources, equipment battle damage information accurate and accurate assessment of the damage state for maintenance to play an important supporting role, therefore guarantee and guarantee the accuracy of the information index can guarantee accuracy, including information accuracy and security the accuracy of the allocation of resources; Due to the complexity of battlefield information, equipment in a state of continual change, based on explicit security resources supply, how to flexibly use and consumption is an important criterion for fighting and economy; Finally, the protection of the comprehensive embodiment, in the design and use of the stage are considered to ensure that the problem, so that equipment can be guaranteed, good security".

Through the above analysis, we can get 8 evaluation indexes of non-lethal weapons comprehensive support effectiveness: warfare integrity (s_1), guarantee resource adequacy (s_2), guarantee economy (s_3), guarantee timeliness (s_4), guarantee informatization (s_5), guarantee accuracy (s_6), guarantee flexibility (s_7), emergency guarantee rate (s_8).

2.2 Evaluation index grade classification

Because the evaluation index is mostly qualitative, the initial evaluation score is obtained by expert scoring. When [0, 1] space is used as scoring interval, 1 means that the guarantee performance is better, and 0 is the guarantee Performance is poor. So the evaluation of different index can be obtained according to expert experience.

3. Evaluation Model of BP Based on Cross Integrated Support Ability

The factors influencing the comprehensive support capability of the non-lethal weapons are more and more complicated, and some factors have non-linear relationship with the trans-regional comprehensive support capability, and some factors are even random. It is difficult to describe this kind of relation accurately by concrete mathematical model. And the BP neural network, by virtue of the self-learning function of artificial neural network, acquires the relationship between the two, establish an implicit relational model, can more accurately reflect the relationship between independent variables and dependent variables.

3.1 Determination of the number of hidden layers

Because a three layer BP neural network can approximate any mapping relation with any precision, it is a simplified model, which adopts three layers of network structure, namely input layer, hidden layer and output layer. The purpose of the hidden layer is to establish the key of the BP network prediction model. Considering the problem of computing resources and computing time consumption, this paper uses the following mathematical models to calculate the number of hidden layer of network[10].

$$n_1 = \sqrt{m+n} + a \qquad (1)$$

In the formula, M is the number of input neurons; n is the number of output neurons; a is the constant between 1-10. 8 hidden layer nodes are selected in this paper. The accuracy required by the training can be achieved.

3.2 Function selection and parameter setting

The transfer function of neuron in BP network is usually Sig-moid differentiable function, so it can realize any nonlinear mapping between input and output. The Tansig function and the Purelin function are used for the transfer functions of the hidden layer and the output layer, respectively.

In the commonly used training function[11], the Traingdm function, which is a batch-driven feed-forward neural network training method, not only has a faster convergence speed, but also introduces a momentum term, which effectively avoids the local minimum Problems arise in network training; Trainlm function, also known as Levenberg-Marquardt algorithm, for the medium-sized BP neural network has the fastest convergence rate, the system default algorithm. Because it avoids the direct calculation of the Hex matrix, it reduces the amount of computation in training, but requires a large amount of memory. In this paper, the traingdm function is selected as the training function of the network. In this paper, the traingdm function is selected as the training function of the network.

The training parameters show that the training iteration process is selected to be 5; the maximum training time is set to 20000; the target error is $1\times e^{-3}$.

3.3 Learning samples

The input data of the learning samples are scored by the experts shown in Table 1. The selection of the output node corresponds to the evaluation result, for which the desired output is first determined. In the neural network learning and training phase, the expected output value of the sample should be a known quantity, which can be given by historical data or evaluated by other mathematical methods such as fuzzy comprehensive evaluation. In this paper, combined with the expert experience, the expected output of the 8 protection schemes are given. Considering the simulation data and its critical value, the protection capability is divided into I excellent (1000), II good (0100), III medium (00 1 0), and IVpoor (0001) grades. The expected output of the guarantee ability is shown in table 1.

TABLE I. Cross-regional Comprehensive Support Capacity Indicators Expert Scoring Data

Array	s_1	s_2	s_3	s_4	s_5	s_6	s_7	s_8	Support Ability Level
1	1.000	0.950	0.763	0.855	0.634	0.850	1.000	1.000	(1 0 0 0)
2	0.900	0.863	0.801	0.750	0.552	0.731	0.695	0.711	(0 0 1 0)
3	0.733	0.452	0.669	0.251	0.587	0.396	0.335	0.452	(0 0 0 1)
4	0.932	0.926	0.913	0.955	0.736	0.814	0.952	0.889	(0 1 0 0)
5	0.619	0.715	0.633	0.728	0.231	0.652	0.158	0.321	(0 0 0 1)
6	0.785	0.754	0.661	0.753	0.569	0.654	0.753	0.773	(0 0 1 0)
7	0.855	0.897	0.752	0.768	0.893	0.886	0.833	0.800	(0 1 0 0)
8	1.000	0.916	0.900	1.000	0.965	0.931	1.000	0.967	(1 0 0 0)

4. Results and Discussion

In order to get a better initial weight, the M file is run repeatedly to ensure the accuracy of the calculation results. From Figure 1 network training record shows, after the 20000 training, although the performance of the network is not 0, but the mean square error of the output has reached about 0.3 * E-3, reached the target value of network training.

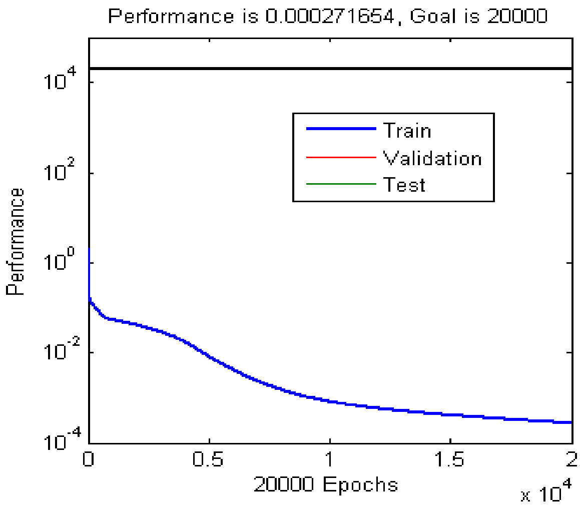

Fig. 1. Network training records

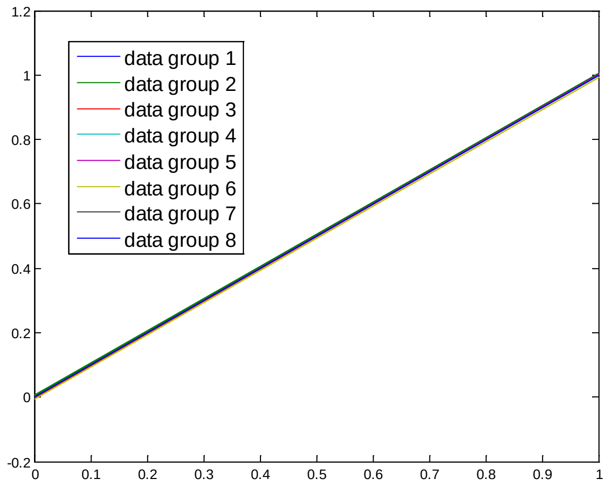

Fig. 2. Network training error curve

From the expected output of the BP network shown in table 2 and the actual output data table can be seen, the 2 sets of data is also higher degree of anastomosis. The error curve of the training data is shown in Figure 2. From the graph we can see that the 8 sets of curves are basically coincident, which further verifies the credibility of the training results.

TABLE II. The expected output and actual output of BP network

Array	**Expected output**	**Actual output**	**Support ability level**
1	(1 0 0 0)	(1.0000 0.0001 0.0000 0.0000)	excellent
2	(0 0 1 0)	(0.0003 -0.0001 1.0000 -0.0000)	medium
3	(0 0 0 1)	(-0.0000 0.0000 0.0000 0.9999)	poor
4	(0 1 0 0)	(0.0000 0.9999 0.0000 -0.0000)	good
5	(0 0 0 1)	(0.0000 -0.0000 -0.0000 1.0001)	poor
6	(0 0 1 0)	(-0.0000 0.0000 1.0000 -0.0000)	medium
7	(0 1 0 0)	(0.0002 1.0000 0.0000 -0.0000)	good
8	(1 0 0 0)	(1.0001 -0.0000 0.0001 -0.0000)	excellent

5. Conclusion

In this paper, the BP neural network method of MATLAB is used to establish the evaluation model of the non-lethal weapon comprehensive support capability of the non-lethal weapon. The test sample is tested and the test result agrees well with the target value. The evaluation model constructed in Armed Police Force Equipment support capability assessment has a certain applicability.

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