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Research On Optimization Method Of Weapon Equipment System Contribution Rate Evaluation Index Based On Meta-Evaluation

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Abstract

The evaluation of contribution rate of weapon equipment system is a research hotspot in the field of equipment demonstration. The establishment of evaluation index system is a key link in the evaluation process.The reasonable selection of index system directly determines whether the evaluation conclusion is scientific and usable.Yuan paper reference evaluation theory and method of contribution rate of weapon equipment system assessment index of yuan assessment process and scale for the design, from the practicability, feasibility, rationality and accuracy of the four aspects meet the consistency, reliability and validity test, as an index design personnel to provide targeted feedback, to optimize the index system, lay the foundation for the follow-up assessment work.

Keywords

Meta-evaluation;Weapon equipment system;Contribution rate;Evaluation index.

1. Introduction

The contribution rate of weapons and equipment system is an original concept in China[1], which is used to comprehensively and scientifically evaluate the role of weapons and equipment in the system, so as to guide the construction of weapons and equipment system and effectively improve the countermeasures capability of equipment system.In the process of evaluating the contribution rate of weapon equipment system (hereinafter referred to as system contribution rate), the establishment of evaluation index system is a very key link. Whether the selection of index system is reasonable will directly determine whether the evaluation conclusion is scientific and usable.

There are abundant research achievements on evaluation index of system contribution rate in China.Literature [2] puts forward six principles of index system construction, and constructs a multi-level evaluation index system from four perspectives of system functional adaptability, system structure optimization, combat ability improvement and system technological progress.Literature [3] analyzes the qualitative relationship among combat effect, combat efficiency, combat cost and combat capability of the system, and constructs the evaluation index system of contribution degree of weapons and equipment combat system from three aspects of enhancing combat effect, enhancing combat efficiency and reducing combat cost.Literature [4] has constructed a multi-dimensional and multi-level index system framework with universality and expansibility from six perspectives: complete function, reasonable structure, effective, advanced, economic and applicable.Literature [5] combines six contribution type indicators, including capacity efficiency, architecture, operation mechanism, model pedigree, economic cost and supporting technology, with problem stage and assessment technology, to construct an overall research framework for three-dimensional system contribution rate assessment.

From the above results, we can find that: (1) At present, the construction of the index system of contribution rate assessment mainly depends on expert experience, and the index system constructed from different perspectives varies greatly;(2) The hierarchical structure of the

index system and the relationship between the indexes are complicated, and unreasonable structure combing is easy to lead to the problems of index omission, index repetition, excessive correlation, weight dispersion and so on; (3) There are many comprehensive indicators, which are difficult to be refined and quantified.In view of the above characteristics of evaluation index, this paper proposes to optimize the evaluation index system of system contribution rate by using meta-evaluation theory.Establish an iterative process from evaluation to meta-evaluation, and then from meta-evaluation to new evaluation, so as to make evaluation index selection as perfect, accurate and objective as possible.

2. Basic Theory

The concept of elementary evaluation was first proposed by Michael Scriven, an American expert on evaluation theory, in his educational Product Report in 1969 [6], and has been widely used in the field of education [7].Since then, it has also been applied in government performance evaluation [8], clothing design [9], archive security [10], military [11] and other fields.

2.1. Contents and Functions

As an affix, "meta" originally came from the Greek prefix "meta-", meaning an inquiry into nature.Meta-evaluation is an exploration into the nature of evaluation.As a branch of meta-science, it is a scientific evaluation of the original evaluation, that is, the existing evaluation activities as the research object, the evaluation structure, evaluation process, evaluation conclusion and other aspects of reflection, in order to modify and improve the process of evaluation activities, with the function of adjusting the original evaluation.In order to optimize and perfect the index system, the meta-evaluation theory and method are applied to the index construction in the evaluation process of system contribution rate.

2.2. Design Idea And Process

Traditional meta-evaluation mainly uses statistical methods to estimate the impact of errors on evaluation results, but the deviations referred to by meta-evaluation are not limited to statistical properties.Assessment bias may be caused by improper psychological cognition of assessment subjects, differences in understanding of assessment issues, and assessment models and means used [12].Therefore, when studying the meta-evaluation method for the evaluation index of system contribution rate, we should focus on the multiple links of deviation sources in the generation process of evaluation index, examine from multiple perspectives, integrate various methods including statistics, and make targeted evaluation.The implementation steps are as follows: (1) Set up a meta-evaluation expert team;(2) Define the objectives and contents of meta-evaluation; (3) Design meta-evaluation scale;(4) Implement meta-evaluation; (5) Processing and analyzing meta-evaluation data;(6) Make meta-evaluation conclusions.The specific process design is shown in Figure 1.

2.3. Index construction and scale design

The standard of meta-evaluation is the basic basis of meta-evaluation and determines the actual effect of meta-evaluation.The Joint Committeeon Standards for Educational Evaluation (JCSEE) has been studying meta-evaluation Standards and scales since 1974. After continuous improvement and revision, four basic Standards are formed, namely, practicality, feasibility, rationality and accuracy [13].Taking the two-level index system as an example, the designed scale is shown in Table 1.

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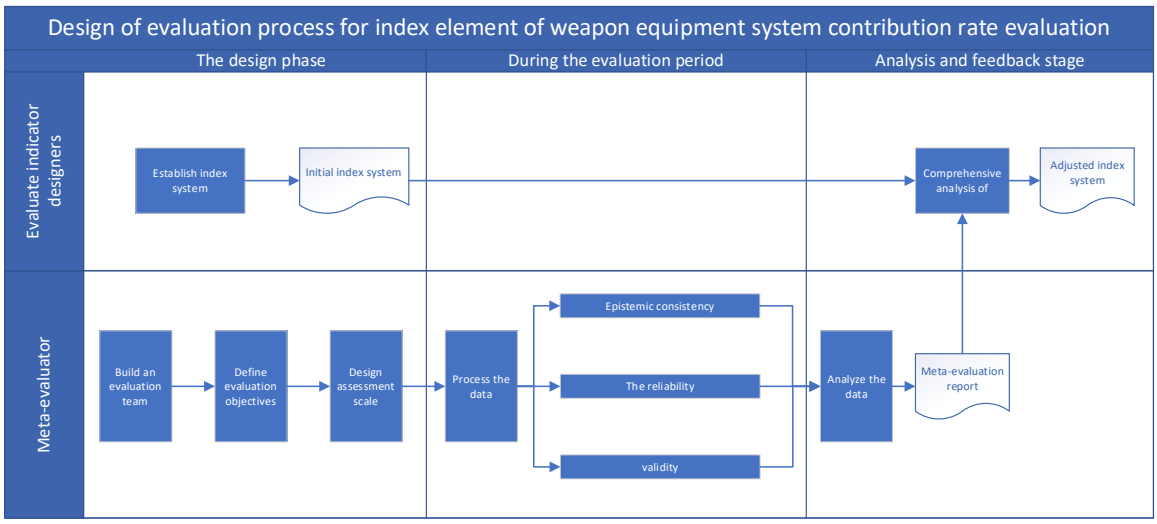

Figure 1: Evaluation flow chart of indicator element of weapon equipment system contribution rate evaluation

Table 1: Design of a meta-evaluation scale

Evaluation indicators		Expert 1				...	Expert j			
		Prac-tical	Feasi-bility	Ratio-nality	Accu-racy		Prac-tical	Feasi-bility	Ratio-nality	Accu-racy
Level indic-ators	Index 1									
	Index 2									
	……									
	Index n									
The seco-ndary indic-ators	Index 11									
	Index 12									
	……									
	Index 1m									
	Index 21									
	Index 22									
	……									
	Index nm									

3. Application

3.1. Set the initial indicator system

From two perspectives of improving equipment system construction and improving combat output effect, this paper constructs the contribution rate of architecture and the contribution rate of combat respectively, and attempts to comprehensively describe each index of the evaluation of system contribution rate.A total of 2 first-level indicators, 9 second-level indicators and 28 third-level indicators were developed, as shown in Figure 2.According to the expert experience, the weight coefficients of the first-level, second-level and third-level indexes

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are determined as $W_1 = [0.31 \quad 0.69]^T$, $W_2 = [0.062 \quad 0.069]^T$, $W_3 = [0.0372 \quad 0.0138]^T$. Taking the above index system as the initial index system, this paper tries to evaluate and optimize it.

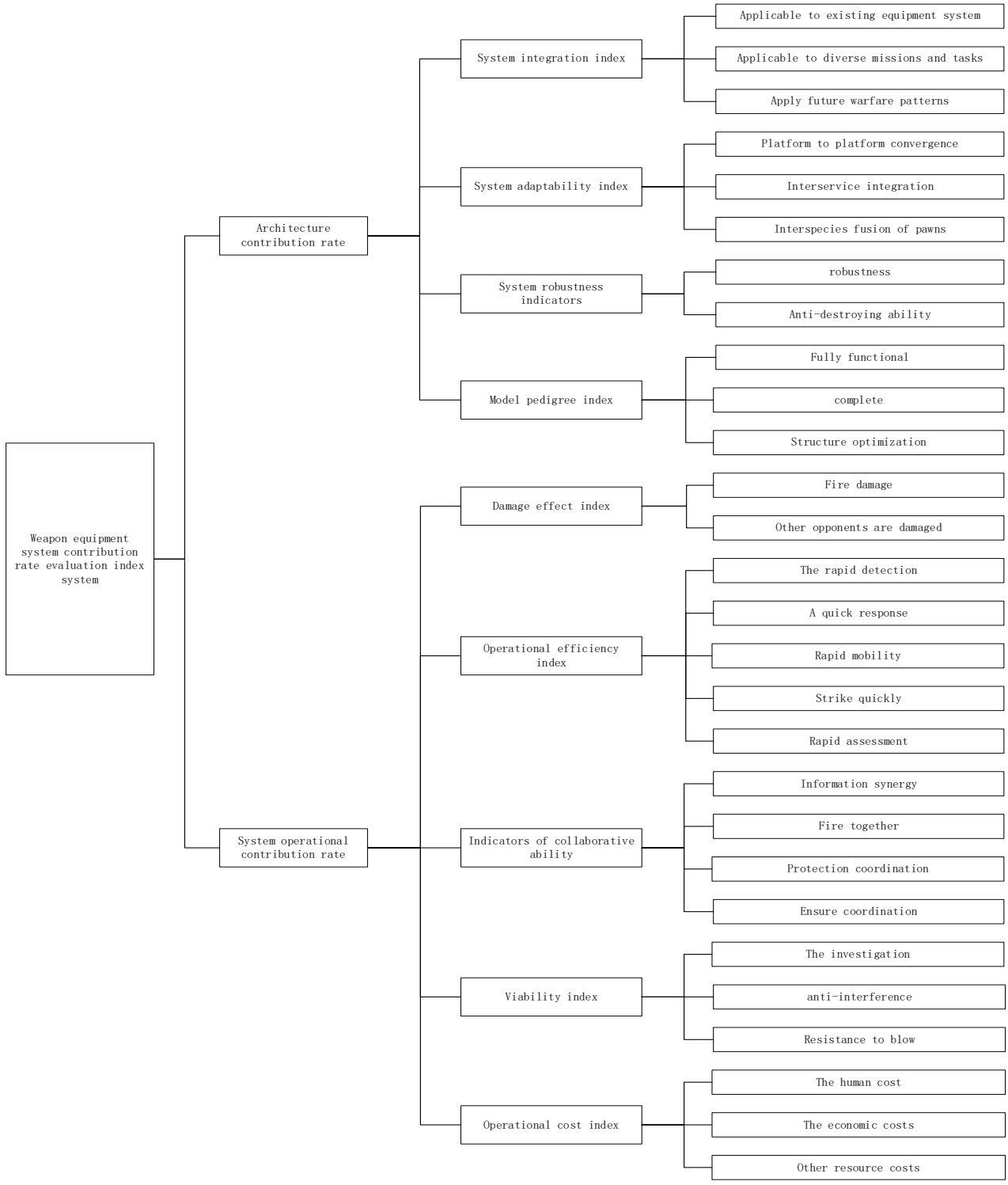

Figure 2: Evaluation index system of weapon equipment system contribution rate

3.2. Design scale for evaluation

A total of 5 experts in the field were invited to carry out the evaluation as meta-evaluation experts, and a 10-point system was used to score the evaluation indicators.The evaluation is divided into ten grades: extremely poor, very poor, poor, unsatisfactory, minimum standard, basically qualified, good, good, very good and very good, and corresponding to 1-10 points in

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sequence.The scoring results of experts on the setting of evaluation indicators at all levels are shown in Table 2.

Table 2: The results of evaluation indicators by domain experts

Evaluation indicators		Expert 1				…	Expert 10			
		Prac-tical	Feasi-bility	Ratio-nality	Accu-racy	…	Prac-tical	Feasi-bility	Ratio-nality	Accu-racy
Level indicators	Architecture contribution rate	85	77	98	87	…	99	97	99	98
	System operational contribution rate	98	98	98	99		87	87	98	87
	Index weight W1			76					87	
The secondary indicators	System suitability index	77	65	87	66	…	87	98	67	76
	System integration index	98	78	87	87		87	87	76	76
	……	……								
	Viability index	98	98	98	87		87	67	98	87
	Operational cost index	98	87	88	88		87	98	67	76
	Index weight W2			87					87	
Level 3 indicators	Adapt to existing equipment system	87	67	77	77	…	88	56	67	67
	Adapt to diverse missions and tasks	77	56	66	66		76	66	76	67
	……	……					……			
	The economic costs	87	98	87	77		87	76	87	87
	Other resource costs	76	67	69	68		87	67	67	67
	Index weight W3			77					87	

3.3. Processing, analyzing and evaluating data

3.3.1. Understanding consistency meta-evaluation

Since there is no unified and clear definition of the concept and connotation of system contribution rate, and the knowledge structure of experts is different, the main body of meta-assessment has great cognitive difference.In order to avoid personal cognitive deviation and thinking set in the meta-assessment appeared strong subjective tendency.First of all, cognitive consistency assessment should be carried out on evaluation subjects.Kendall harmony coefficient method is used here.Taking the first-level index "architecture contribution rate" as an example, ranking the scoring results of practicality, feasibility, rationality and accuracy by experts (the highest score is 1, the second score is 2...), because there may be multiple scores of the same grade, kendal harmony coefficient should be calculated by correction formula:

$$W = \frac{S}{\frac{1}{12}K^2\left(N^3 - N\right) - K\sum T} \tag{1}$$

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Among them ,

$$S=\sum\left(R_j-\frac{\Sigma R_j}{N}\right)^2, T=\frac{\sum\left(t^3-t\right)}{12} \tag{2}$$

In the formula, W is Kendall harmony coefficient, K is the number of evaluators, N is the number of evaluators, R_j is the sum of the number of evaluation grades of the JTH object obtained by all evaluators, and t is the number of scores of the same grade.The above evaluation is a small sample ($K \le 20$ and $N \le 7$). According to the Kendall Harmony Coefficient Critical value Table, if the calculated value is greater than or equal to the critical value, it is considered to be consistent; otherwise, it is considered to be inconsistent [14].Thus, the consistency of the evaluation results of "architecture contribution rate" by experts is obtained.In order to test the cognitive consistency of the whole evaluation index system, all 39 indexes need to be verified and calculated. If there is any inconsistency, the reasons for the divergence of experts' opinions can be further explored. The evaluation indexes with large differences among experts often have problems such as unclear meaning and inaccurate description, so full attention should be paid to them.

3.3.2. Evaluation of index system reliability element

In the process of meta-evaluation, special attention should be paid to the internal structure of the index system, so as to build a high confidence index system with strong independence, good internal structure and consistent index relationship.The kronbach coefficient method can be used for evaluation.The calculation formula is:

$$\alpha=\frac{K}{K-1}\left(1-\frac{\sum S_i^2}{S_t^2}\right) \tag{3}$$

In the formula, α is The Kronbach coefficient, K is the number of evaluation indicators (when the evaluation indicator system contains several sub-indicator layers, K is the total number of indicators contained in the sub-indicator layer), S_i^2 is the variance of the score of item I, and S_t^2 is the variance of the total score of evaluation.Ratio evaluation index assessment system is practical, for example, K value of the underlying index number 28, S_t^2 experts for all 28 indicators practical a score of total variance, S_i^2 as experts on every single index practical a score variance, calculate α similarly can calculate the feasibility, rationality and accuracy of α value.The value is between 0 and 1, and the larger the value is, the higher the reliability is.It is generally believed that α should be above 0.8, and the evaluation index has good reliability; otherwise, the index needs to be adjusted;When the reliability is below 0.35, it must be rejected.

3.3.3. Validity element evaluation of indicator system

Validity of evaluation index refers to the extent to which the evaluation index can describe the feature category of the evaluation object and reflect the evaluation purpose [15].In order to test whether the designed index system can fully and objectively reflect the contribution of newly developed equipment to the original equipment system, the validity element evaluation of the system contribution evaluation index system is carried out.Content validity ratio (CVR) is commonly used to evaluate the validity of evaluation indexes, and the calculation formula is as follows:

$$CVR=\frac{ne-\frac{N}{2}}{\frac{N}{2}} \tag{4}$$

In the formula, ne is the number of evaluation subjects who believe that an index represents the evaluation object category well.N is the total number of evaluation subjects.Taking the rationality index of "adapting to the existing equipment system" among the three-level indicators as an example, it is assumed that "good" (7 points) or above in the 10-point system is the subject satisfaction standard, and 10 is the number of experts who score more than 7. The CVR is calculated as 0.2.Similarly, the CVR values of each index and the weight of each index layer can be obtained.The CVR value is between -1 and 1, and the larger the value is, the higher the validity is.When $CVR < 0$, it means that the number of experts who think this indicator is appropriate is less than half, and the indicator needs to be revised.

3.4. Feedback evaluation results

The relationship between component elements and structure of weapon equipment system itself is very complicated. In order to select perfect and accurate evaluation index of contribution rate as far as possible, it is necessary to draw on the idea of meta-evaluation to construct evaluation feedback loop.The meta-evaluation results will be fed back to the designer of evaluation indicators in the form of report, and the indicators will be revised and put into the next meta-evaluation.After so many times of evaluation, repeated iteration, constantly improve the credibility of evaluation indicators.

4. Conclusion

In the process of evaluating the contribution rate of weapon equipment system, the selection of evaluation index is a very key link, which determines whether the evaluation conclusion is scientific and usable.By introducing the idea of meta-evaluation into the selection of the index of contribution rate of the system, it can make full use of expert experience to test the practicality, feasibility, rationality and accuracy of the index system, and provide targeted feedback for the index designers, so as to optimize and perfect the index system and lay a good foundation for the follow-up evaluation.

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