The System Adaptability Evaluation Index System of Military Communication Equipment System

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ABSTRACT

As an objective reflection of equipment combat performance and battlefield satisfaction, the equipment combat test evaluation index system is the premise and basis for equipment combat test planning, design and implementation. It is to assess the system integration ability and matching ability of military communication equipment under actual combat conditions and the ability to join the equipment system for operation and training. This paper analyzes the concept connotation of system adaptability, system integration degree and system contribution rate, defines the construction principles and ideas of equipment system adaptability evaluation index system, and establishes an index system reflecting the adaptability of military communication equipment system from two aspects of system integration degree and system contribution rate, so as to provide theoretical reference and technical support for military communication equipment system adaptability evaluation.

CCS CONCEPTS

• **Theory of computation**; • **Theory and algorithms for application domains**;

KEYWORDS

Military communication equipment, System adaptability, System integration degree, System contribution rate

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1 INTRODUCTION

Modern war presents the development trend of networking and systematization. Following the information age, driven by digital, networked and intelligent technologies, the paradigm of equipment development and application is changing from platform based operations to system based operations. It is a very difficult task to scientifically, accurately and systematically evaluate the system adaptability of a certain communication equipment to the weapon equipment system[1]. On the one hand, the relative, hierarchical and progressive characteristics of system adaptability make it difficult to grasp the evaluation indexes and influencing factors of system adaptability[2]; On the other hand, the structure of the system of systems network and the complex relationship between various weapons and equipment make it difficult to build the evaluation model. In view of these difficulties, experts in relevant fields have made the following analysis and research. Reference [3] holds that the main battle equipment, information equipment and support equipment have their own characteristics, and their contribution degrees have their own emphasis. Different evaluation methods should be adopted. The basic connotation of the system contribution degree of the main battle equipment is analyzed from the perspective of the combat effectiveness evaluation of the weapon equipment system, and an analysis method based on causal traceability is proposed. Reference [4] believes that the contribution of weapons and equipment to the system can be expanded from the support of equipment to mission and task, decomposes the weapon and equipment system into the hierarchical structure of mission, task, capability and equipment, and gives the definition of the system contribution of equipment as: the support degree of each equipment in the weapon and equipment system to the completion of mission and task of the whole system, The methods and steps of weapon equipment contribution evaluation based on task are

studied. Reference [5] discusses the concept and connotation of electronic information equipment system contribution, puts forward the evaluation method model of electronic equipment system contribution, and gives the evaluation idea based on grey target theory and system countermeasure experiment. Starting with the technical maturity and system integration of major naval equipment, Reference [6] studied the contribution evaluation method of major equipment to the combat capability of naval weapon equipment system. From the perspectives of system contribution rate and system adaptability, this report constructs a perfect adaptability evaluation index system of military aerospace equipment system, which can provide important theoretical basis and basis for comprehensive evaluation.

2 CONCEPT CONNOTATION OF SYSTEM ADAPTABILITY EVALUATION

System adaptability refers to the availability of weapons and equipment in system of systems[7,8]. When designing the system adaptability index, we should first clearly define the system. The system concepts related to military communication equipment mainly include combat system, weapon equipment system and network information system. The combat system is an organic whole composed of combat system according to certain command and control relationship, organization relationship and operation mechanism. The weapon equipment system is a higher-level weapon equipment system, which is interrelated in function and complementary in performance. Various weapon equipment systems are integrated according to a certain structure[9]. The network information system is an organic whole of all kinds of information systems at all levels, which is supported by the common information infrastructure of the whole army and integrates functional systems such as command and control, early warning detection, intelligence reconnaissance, information confrontation and battlefield environment [10, 11]. In addition to the contribution of the equipment itself to the system capability, the factors affecting the weapon equipment system capability also include the degree of integration among the constituent elements of the system. Therefore, the adaptability evaluation index of military communication equipment system can be divided into two secondary capability indexes: system integration degree and system contribution rate.

(1) The system integration degree is mainly used to assess the integration degree of military communication equipment with other systems after being integrated into the weapon equipment system, which can be measured from the perspectives of complex environment adaptability, support adaptability, operation adaptability and organization adaptability [12].

(2) The system contribution rate is mainly used to assess the contribution of military communication equipment to the improvement of its own combat system combat capability, combat effectiveness or task completion effect. The system contribution rate of weapon equipment can be analyzed from two perspectives: system capability contribution rate and system effectiveness contribution rate.

On the whole, some achievements have been made in the interpretation of the connotation of weapon equipment system adaptability, but on the whole, it is in the exploration and initial stage. It is necessary to carry out more in-depth research on the concept of system adaptability evaluation and the construction of evaluation index system.

3 CONSTRUCTION PRINCIPLES AND IDEAS OF SYSTEM ADAPTABILITY EVALUATION INDEX SYSTEM

3.1 Basic Requirements for Index System Construction

For the construction of system adaptability evaluation index system, we need to grasp some basic requirements:

(1) The evaluation index shall fully reflect the operational requirements. The system adaptability evaluation index is usually determined subjectively by the evaluator according to the evaluation purpose. The selection of the index should be repeatedly and comprehensively balanced. The key is whether it can represent the real combat target and evaluation target of the equipment system.

(2) The evaluation index is related to the typical scenario. Different missions of weapons and equipment lead to different results of combat effectiveness. The evaluation of operational effectiveness must be carried out under certain threat targets, countermeasures and tactical background conditions. Comparing the operational effectiveness of the two types of equipment should also be carried out under the same operational scenario. The US National Defense Acquisition guide emphasizes that "the identification of combat effectiveness is closely related to the completion of combat tasks". There is no unique, fixed, absolute and independent combat effectiveness value other than combat tasks, threat targets, confrontation and tactics for any equipment. Because there may be many operational scenarios for type I equipment in actual use, evaluating and calculating one by one is not only a huge workload, but also inconvenient for comparative analysis. In practical application, some typical scenarios are usually formulated for evaluation and analysis.

(3) Multitasking system is characterized by multiple indicators. During the development of each weapon system, its mission focus, function focus and service conditions are different. Each mission has its corresponding operational effectiveness index value. It is not always feasible and appropriate to integrate the operational effectiveness of these different missions into a single effectiveness index. It is meaningless to compare the advantages and disadvantages of different equipment. Therefore, for multitasking systems, both primary and secondary tasks are generally considered. For example, some air defense missile systems focus on air defense, supplemented by anti-missile, and some focus on anti-missile and supplemented by air defense; Combat aircraft generally includes three tasks: air-to-air combat, air strike interdiction and short-range support. The main tasks of different combat aircraft are different, and the main tasks of the same aircraft in different countries are also different.

3.2 Index System Construction Process

The evaluation index system shall fully reflect the requirements of evaluation objectives and be scientific, reasonable and practical. Therefore, the evaluation index system needs to formulate and optimize the first draft of the evaluation index system on the basis

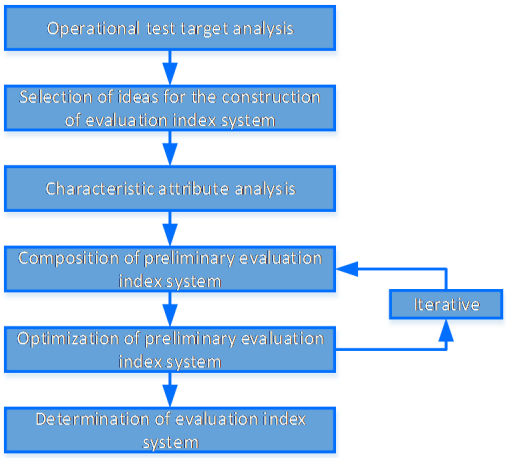

Figure 1: The Construction Process of Evaluation Index System.

of systematic analysis of operational test objectives, and finally determine the evaluation index system through repeated iterations through expert consultation, as shown in Figure 1

(1) Target analysis of operational test qualification

The objective analysis of operational test evaluation is the premise of evaluation index, which determines the type of evaluation index system and the focus of evaluation.

(2) Selection of design ideas for operational test evaluation

It mainly includes operational test appraisal ideas based on specific tasks, comparison of similar equipment and key operational problems, which are selected according to the general development requirements and operational test appraisal objectives.

(3) Characteristic attribute analysis

It mainly defines the essential attributes of each index, i.e. qualitative index or quantitative index, so as to lay a foundation for establishing mathematical model and obtaining evaluation data.

(4) Formation of the first draft of the evaluation index system

According to the type of index system, the first draft of evaluation index system is formed by using scientific analysis method.

(5) Optimization of evaluation index system

According to the construction principle and importance ranking of the evaluation index system, the indexes are deleted and combined to achieve the purpose of simplifying the number of indexes and optimizing the overall structure.

(6) Iterative

The optimized evaluation index system is modified and improved by means of expert consultation, questionnaire survey, conference discussion and so on.

(7) Determination of evaluation index system

The level of detail of the relevant information of the evaluation index system is related to the subject design, data acquisition and evaluation of operational test. The relevant information usually includes the meaning, nature, threshold, mathematical model or description method of the index.

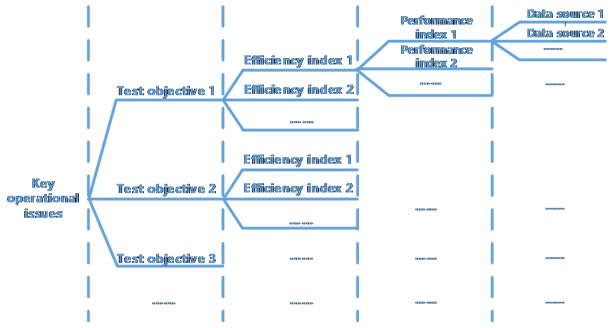

Figure 2: The Analysis Methods Based on Key Operational Problems.

4 CONSTRUCTION OF SYSTEM ADAPTABILITY EVALUATION INDEX SYSTEM

4.1 Construction Method of Evaluation Index System

The construction of adaptability evaluation index system of military communication equipment system usually starts from the mission and task of the equipment, puts forward the equipment capability requirements and key combat problems, and then uses relevant methods to generate an index system with good structure, clear meaning and easy measurement according to the characteristics of the tested equipment. In this paper, the tree decomposition method based on key operational problems is used to construct the evaluation index system.

The tree decomposition based on key operational problems is to gradually decompose the key problems into a hierarchical tree structure, that is, the key operational problems are gradually decomposed to the extent that the actual data requirements and test measurements can be determined. From high level to low level, there are key operational issues, test objectives, effectiveness indicators, performance indicators and data sources, as shown in Figure 2. Each key operational problem and its related effectiveness indicators are also associated with one or more performance indicators, which are interconnected with specific data sources. The data source is the observed value or measured value of the evaluation index obtained from the operational test under the specified conditions.

4.2 Military Communication Equipment System Adaptability Assessment Requirements

The military communication equipment belongs to the category of complex electronic system. Due to its special needs in application, it shows different technical characteristics, which are mainly summarized as follows:

(1) Typical information equipment. The basic feature of information equipment is information sharing and information exploration and utilization. Its basic processing object is battlefield information from multiple types and heterogeneous sources. Its basic driving force

is the change of battlefield information. Its basic operation unit is battlefield information flow, and its basic goal is to optimize the utilization of battlefield information.
(2) Multi site distributed structure. Command military communication equipment is usually divided into military divisions, brigades and regiments, battalions and companies, and one or more unit vehicles at each level realize the functions of command and control, information transmission, information processing and so on; Geographically, the command posts are distributed in an area of tens to hundreds of square kilometers.
(3) High degree of technology integration, advanced equipment. The field of equipment technology covers a number of technologies such as communication, information fusion and decision-making assistance, which are developing at a very fast speed. The main equipment of the system includes information processing equipment, communication equipment, positioning equipment, etc., which reflect the latest progress of the military information equipment.
(4) It has the technical characteristics of multi-protocol and standard combination. The communication of commanding military communication equipment involves many tactical networks with different protocol types, such as command private network, field area network, (primary) Tactical Internet, etc. In order to ensure the network compatibility, a variety of special control protocols, conversion equipment and a large number of configuration software are used to realize the multi-protocol standard integration, and the underlying technology is very complex.
(5) It has the characteristics of high coupling of software and hardware. Due to the complexity of information flow and conversion protocol, the functional coupling between software and single equipment is closer, and the decoupling analysis of software and hardware is more difficult. In the system, a software function is often associated with several related devices, and a hardware failure often causes a variety of functional abnormalities.
The above-mentioned characteristics make the relationship between the evaluation index system of military communication equipment complicated. The rationality of the index system is related to the scientificity of test design and the completeness of data collection, and directly affects the quality and benefit of combat tests.

4.3 Military Communication Equipment System Adaptability Evaluation Index System

The most typical characteristics of military communication equipment system are integrity and antagonism. The biggest difficulty of equipment system adaptability evaluation is how to quantify the evaluation index system. Based on a certain type of military communication equipment, for example, according to the characteristics of the equipment as well as the mission, from two aspects of the system alignment and system contribution rate, considering the participants information fusion between equipment and related subject equipment, system integration, system integration and the application of the inter-communication reuse ability, establish system adaptability evaluation index system, provide the basis for carrying out evaluation work. The adaptability evaluation index system of military communication equipment system is shown in Table 1

5 THE INSPECTION METHOD OF EVALUATION INDEX SYSTEM

After continuous optimization and improvement, the index system can be tested for its rationality by means of connotation test or value preservation test, so as to timely find the existing problems and deficiencies, modify and improve them, and finally make the evaluation index system serve the evaluation work well. The inspection of the index system needs to focus on the integrity, rationality and effectiveness of the index system.
(1) The integrity inspection
The integrity inspection is mainly to check whether there are omissions and overlaps in the evaluation index system to ensure the mutual independence of indicators at the same level. The merging refers to merging the overlapping indicators into one indicator, and the separation refers to extracting the overlapping parts to form a new indicator. The integrity of the evaluation index system can be tested by means of expert review.
(2) The rationality test
The purpose of rationality test is to test whether the evaluation index system can scientifically and reasonably reflect the essence and characteristics of evaluation. When constructing the index system, we should comprehensively consider the fine requirements of the evaluation conclusion, use the weight comparison method to analyze and screen the index system, and remove some indicators with too small weight, so as to simplify the evaluation index system.
(3) The effectiveness test
The effectiveness test is mainly to optimize and adjust the situations with large differences in the evaluation data. For the same evaluation index, there may be some deviation in the understanding of its importance by different appraisers, resulting in that the evaluation results can not truly reflect the evaluation object. The validity coefficient method can be used to test the effectiveness of the evaluation index system.

6 CONCLUSION

Carrying out system adaptability evaluation is the key link to effectively test whether military communication equipment can meet the actual combat requirements, and it is an important support for equipment construction decision-making. This paper analyzes the construction methods and steps of the adaptability evaluation index system of military communication equipment system in detail, which can effectively support the completion of the system adaptability evaluation, and provide reference for the scientific construction of other relevant evaluation index systems. However, the adaptability evaluation of military communication equipment system is a complex system engineering. According to the different requirements of test tasks, the emphasis of evaluation is also different. In the actual evaluation process, it is also necessary to increase or decrease and improve the index system according to the specific task requirements, and further refine the collection and calculation method of the underlying indicators, so as to obtain the relatively objective evaluation results reflecting the actual combat effectiveness.

Table 1: The Adaptability Evaluation Index System of a Military Communication Equipment System

Capability index	Efficiency index	performance index	Performance metrics
System integration degree	electromagnetic environment adaptability	EMC degree	transmit bandwidth modulation mode band ratio
	guarantee adaptability	guarantee difficulty	power on time Interface length interface angle maintainability level
		repair difficulty	detection time average repair time time between failures
	operational adaptability	degree of interoperability	mechanical connection mode electrical parameters
	organizational adaptability	weaving matching degree	charge range
system contribution rate	contribution rate of system combat capability	information support capability	intelligence reconnaissance capability information transmission capability information processing capability information sharing capability
		command and decision-making ability	auxiliary decision-making ability integrated command and control coordination capability fire coordination support capability
	contribution rate of system combat effectiveness	reconnaissance Detection	reconnaissance detection speed reconnaissance detection probability false alarm rate
		judge	IFF probability target fusion probability
		decision evaluation	recognition speed target allocation speed
		action	launch preparation time hit accuracy effective strike rate

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