Matching Assessment of the Chassis and Fire System of Wheeled Vehicle Mounted Gun Based on the Index (0,2) Scale

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Abstract. The matching problem of the cannon and vehicle has been studied a lot, but the studies are more about the self-propelled guns with armored chassis, studies of the truck-mounted artillery with truck chassis are less now. AHP method is used in this paper and the vehicle chassis and artillery fire system matching evaluation factors are listed in this paper, the evaluation system is been established and a evaluation model is built in the end. Aiming at the disadvantages of the traditional AHP method in the proportion of 1-9 scaling, the (0,2) index scale is used in this paper, the judgment matrix which meets the consistency requirements is built and the subjective of the judgment matrix is reduced.

1 Introduction

The matching of the chassis system and fire system means the reasonable degree and consistency of the chassis system and fire system of the associativity in structure and performance, Included in the thermal reliability, flexibility, such as mechanical strength performance and the overall performance of the composite system to achieve the optimal. Now, some internal scholars, like Mao Baoquan and Mu Ge[1,2] have did some studies for self-propelled guns with armored chassis, but the study of the truck-mounted artillery with truck chassis is less now. This paper mainly aims at the matching problem of the chassis system and fire system of Vehicular artillery, lists the evaluation factors and establishes the evaluation system and evaluation model. Wish to provide certain reference for the matching of the chassis system and fire system of Vehicular artillery.

2 Evaluation factors and evaluation system

2.1 Evaluation factors

Vehicular artillery is different with self-propelled guns, the truck chassis needs to be considered more when choosing the evaluation factors.

By analysing and researching the combat and load characteristics of the vehicular artillery platform, the main factors which impact the platform's mechanical properties and mechanical properties is confirmed. By asking experts and actual measurement, the main evaluation factors are listed in the following Table 1:

Table 1. Main evaluation factors

evaluation indices	Structure match	performance match
evaluation factors	Length of vehicle	Vehicle body angle of maximum amplitude
	Length-width ratio of vehicle	Vehicle body vertical (horizontal) to the angular displacement
	Height of chassis	Ratio of vehicle and cannon
	Barycentric position of the chassis	Height of the fire line
	Chassis seat minimum area	March battle conversion time
	Seat position	Firing rate
	Shape of seat	The vertical (horizontal) to the angular displacement of the muzzle
	The limit of Combat weight	The vertical (horizontal) to the angular velocity of the muzzle velocity
	The hoe connected position	The vertical (horizontal) to the angular acceleration of the muzzle
	Limit took long	Battle-sight range

2.2 The establishment of evaluation system

Combining with evaluation index and the main evaluation factors and using the AHP method, the evaluation system is divided into target layer, criterion layer and layer solution.

3 The method of (0,2) index scale

Analytic hierarchy process, referred to as 'AHP', is a kind of multi-objective multi-criteria decision-making method.

So-called index scale method[3] is the two factors of group compared to the importance of the C_i and C_j are divided into several levels, as $C_{ij} = 1,2,...$ With the introduction of two adjacent level objective importance ratio $a(a>1)$, so the objective importance ratio of C_i and C_j is $a^{c_{ij}} = w_i / w_j$, where w_i and w_j represent the objective importance of i and j respectively, $C = (C_{ij})_{n\times n}$ and $B = (a^{b_{ij}})_{n\times n}$, respectively called subjective feeling matrix and objective difference judgment matrix. Then using the logarithm least squares method in matrix B, and get the vector $\overline{\omega}$ containing parameter a by using the row sum of the matrix C, the weight vectors can be got after determining and normalizing the value of a. Where, $b_{ij} = r_i - r_j$.

Many methods can be used to confirm the value of a: Through designing the questionnaire a is equal to 1.361. According to the "ladder by leaps" principle, the literature [4] get a is equal to 1.618. While the literature [5] shows that to the parameter $a(a>1)$, if any disturbance Δa meet the condition that $a+\Delta a>1$, the ranking result before and after the disturbance will not change. So whether the value of a is equal to 1.361 or 1.618, might change is the finally weight of each index, but the finally sorted result will not change. In this paper a is equal to 1.361.

4 The establishment of the evaluation model

4.1 Hierarchical single sort

First, establish the subjective feeling matrix C which the criterion layer to the target layer, through expert scoring method, using (0,2) index scale to establish the subjective feeling matrix and the rank of the importance of each element is as follows:

Subjective feeling matrix C and its row sum r_i:

$$C = \begin{bmatrix} 1 & 0 \\ 2 & 1 \end{bmatrix} \quad r_i = \begin{pmatrix} 1 & 3 \end{pmatrix}$$

Objective importance ratio a is equal to 1.361 and then get the objective difference judgment matrix B:

$$B = \begin{bmatrix} 1.361^0 & 1.361^{-2} \\ 1.361^2 & 1.361^0 \end{bmatrix} = \begin{bmatrix} 1 & 0.5399 \\ 1.8523 & 1 \end{bmatrix}$$ Using the logarithmic least squares method to find the parameters of the vector a:

$$\overline{\omega} = \left(a^{\left(\sum_{j=1}^{n} b_{1j}\right)/n}, a^{\left(\sum_{j=1}^{n} b_{2j}\right)/n}, \ldots, a^{\left(\sum_{j=1}^{n} b_{nj}\right)/n} \right) \quad (1)$$

Let a equals 1.361: $\overline{\omega} = \left(1.361^{-1}, 1.361^{1}\right)$

Weight sorting after normalized $\omega = (0.35, 0.65)$

Using the same method, the effect weight of each factor under B_1 B_2 can be calculated:

$$\omega_1 = (0.0021, 0.0076, 0.0261, 0.3072, 0.0141, 0.5688, 0.0041, 0.0076, 0.0483, 0.0141)$$

$$\omega_2 = (0.0211, 0.0114, 0.0392, 0.0726, 0.0062, 0.0018, 0.4611, 0.2489, 0.1344, 0.0033)$$

4.2 Hierarchy total sorts

Using ω ω_1 ω_2 from section 3.1, weight sorting of each element of index layer to the target layer can be calculated, the result is listed in the following Table2:

Table 2. Weight

ij	11	12	13	14	15	16	17	18	19	110
weight	0.00073	0.00266	0.00914	0.10752	0.00494	0.19908	0.00144	0.00266	0.01691	0.00494
ij	21	22	23	24	25	26	27	28	29	210
weight	0.0137	0.00741	0.02548	0.04719	0.00403	0.00117	0.29972	0.16179	0.08735	0.00214

We can see that barycentric position of the chassis, seat position and the vertical (horizontal) to the angular displacement of the muzzle have great influence to the target layer. While the length of vehicle and the firing rate have less affect to the target layer.

4.3 The establishment of the evaluation model

Evaluation models are for some factors which cannot direct quantitative or the non-quantitative factors, on the basis of past experience the experience model is set up, by using the evaluation models we can do quantitative evaluation to the non-quantitative factors. The commonly used evaluation models have maximum model, minimum model, normal distribution model, two sides model, middle model.

The evaluation models of each evaluation index are as follows:

Table 3. Evaluation models of each evaluation index

evaluation index	**evaluation model**	**evaluation index**	**evaluation model**
Length of vehicle	middle model	Vehicle body angle of maximum amplitude	minimum model
Length-width ratio of vehicle	middle model	Vehicle body vertical (horizontal) to the angular displacement	minimum model
Height of chassis	minimum model	Ratio of vehicle and cannon	middle model
Barycentric position of the chassis	middle model	Height of the fire line	middle model
Chassis seat minimum area	maximum model	March battle conversion time	minimum model
Seat position	middle model	Firing rate	maximum model
Shape of seat	normal distribution model	The vertical (horizontal) to the angular displacement of the muzzle	minimum model
The limit of Combat weight	minimum model	The vertical (horizontal) to the angular velocity of the muzzle velocity	minimum model
The hoe connected position	normal distribution model	The vertical (horizontal) to the angular accelerationof the muzzle	minimum model
Limit took long	maximum model	Battle-sightrange	maximum model

5 Conclusion

In the past in the application of layer analysis method to solve practical problems, it is often caused deviation when building the judgment matrix due to our subjective consciousness. The method of (0,2) index scale is used in this paper, our subjective consciousness when building the judgment matrix is reduced, simple and good flexibility. The vehicle chassis and artillery fire system matching evaluation factors are listed in this paper, the evaluation system is been established and a evaluation model is built in the end.

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