CALCULATION METHOD FOR DETERMINING INFORMATION CRITERIA IN RECONNAISSANCE DATA PROCESSING

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In this paper, the methods of determination of various information criteria in reconnaissance data processing have been considered. The methods of determination of a reliability of the reconnaissance information source, of quantitative assessment and analysis of properties of a reconnaissance source have been offered. These methods can be applied in combat front zone for reconnaissance data gathering and processing, for assessment of data accuracy The method of quantitative assessment and analysis of reconnaissance data accuracy and assemble has been offered in consideration of the entropy of reconnaissance data. This method can be applied for reconnaissance data processing. The problem of information value loss in reconnaissance data processing has been considered. The calculation method of reconnaissance information accuracy has been considered in one example. These methods will increase the effectiveness and rationality of using of the reconnaissance forces and means.

Key words: *military reconnaissance, data processing, information source reliability, data ~~truthfulness~~ accuracy, information entropy, information significance, information accuracy.*

1. INTRODUCTION

The planning of combat activities and reconnaissance data gathering is the intelligence division duty. Therefore, it is important that these obtained reconnaissance data should be accurate. In the same time, the obtained reconnaissance data from troops should be accurate, too. Because, based on these data the commanders will make a decision. In consideration of information value, during processing of obtained data from the intelligence divisions, the source reliability, data accuracy and information value should be taken into account and evaluated. In addition, during determination of information value it is important to evaluate the information accuracy. This evaluation should be carried out by quantitatively, it will useful for reconnaissance data processing and will increase the effectiveness, and provide a rational use of reconnaissance forces and means. Thus, a problem of determination of the information accuracy method and keeping control has been formed.

For a long time many experts in reconnaissance field have investigated this problem [Mamedov V., Bayramov A., 2019; Platt W., 1997; Bayramov A., Mamedov V., 2019, p.71]. There are very few published articles concerning these investigations in the public sources. On the other hand, the analysis of these articles shows that these evaluations are mainly theoretical. Thus, the goal of this paper is development of the methods of quantitatively evaluation of a reliability of reconnaissance information source, data accuracy, and an information accuracy based on the information value.

2. DETERMINING THE RELIABILITY OF RECONNAISSANCE INFORMATION SOURCE

Reliability determination of reconnaissance information source can be conducted by the evaluation of its properties [Mammadov V., Bayramov A., 2019, p.43]. There are several

possible properties of the information sources (m_x):

- experience (0.9 – full level; 0.5 – sufficient level; 0.1 – low level);
- data presentation with details (0.9 - full; 0.5 - middle; 0.1 - poor);
- completeness of presented data (0.9 - full; 0.5 - middle; 0.1 - poor);
- presented data lag (0.9 – in time presented; 0.5 – it is impossible to determine; 0.1 - data lag);
- comprehensiveness of the range of subject (0.9 – full involved; 0.5 – not full involved; 0.1 – not involved);
- fullness of the text of data (0.9 – full text; 0.5 - it is impossible to determine; 0.1 – not full text);
- quality of the text (carelessness in the text can held to loss ~~an~~ of understanding) (0.9 – full clear; 0.5- not full clear; 0.1 – not clear);
- ~~itself~~ personal interests of the source and impact on data (0.9 – itself interested; 0.5 – it is neutral; 0.1 – not itself interested).

As indicated above, the quantitative~~ly~~ evaluation and consequent summation of the properties of reconnaissance information source have been offered:

$$\boldsymbol{m_x} = \sum_i g_i \qquad (1)$$

Here, g_i – are indications of the source properties.

An experience – is an expertise level in some field of knowledge. An experience can be calculated as below:

$$\boldsymbol{K_i} = \frac{N_i^u}{N_i^c} K_t \qquad (2),$$

Here: i – is a source, N_i^u- is a number of successful results of the reconnaissance tasks, N_i^c- is a number of total reconnaissance tasks, K_t – is a factor of length of the reconnaissance service.

The length of a reconnaissance service of the reconnaissance source is:

$$\boldsymbol{K_t} = \frac{T_i}{T_o} \qquad (3),$$

Here: T_i – is a sum of the reconnaissance source service, T_o – is a total military service (as a rule 20 years).

An information source reliability (M_e) can be calculated as below:

$$\boldsymbol{M_e} = \frac{m_x}{x} \qquad (4),$$

Here: m_x- is a sum of indications of the source properties, $\boldsymbol{x}$ – is a number of properties.

Washington Platt had offered to divide an information source reliability (M_e) into categories [6]. In addition, For the purpose of use of an information source reliability in calculations, the quantitatively evaluation is offered: the full reliability source – 0.9; the usually reliability source – 0.8; the enough reliability source – 0.6÷0.7; every time not reliability source – 0.4÷0.5; not reliability source – 0.2÷0.3; impossible to determine a reliability of source – 0.1.

Thus, it is reasonable to take into account ~~of~~ the determination of reliability of reconnaissance source for evaluation of data ~~truthfulness~~ accuracy during gathering and processing of reconnaissance data in the front zone [Mammadov V., Sabziev E., Bayramov A., 2019, p.42].

3. DETERMINATION OF RECONNAISSANCE DATA ACCURACY

Sherman Kent constructed a diagram that demonstrates a dependence of the probability of reconnaissance data accuracy on accuracy degree, from pro to con [Jack Davis, 2002]. Let us represent this idea by analytical methods. Let P be a probability of reconnaissance data accuracy in percentage.

Let us represent pro and con by analytical methods as below

$$pro = 10 \cdot \frac{P}{100\%}$$

and

$$con = 10\left(1 - \frac{P}{100\%}\right)$$

Then, the next conditions can be represented:

P∈(80 ÷ 100)% ⇒ pro∈(0.8 ÷ 1) ∧ con ∈ (0 ÷ 0.2) - reconnaissance data is an absolutely truth;

P∈(60 ÷ 80)% ⇒ pro∈(0.6 ÷ 0.8) ∧ con ∈ (0.2 ÷ 0.4) - reconnaissance data have a large chance to be a truth;

P∈(40 ÷ 60)% ⇒ pro∈(0.4 ÷ 0.6) ∧ con ∈ (0.4 ÷ 0.6) - reconnaissance data have a fifty-fifty chance to be a truth;

P∈(20 ÷ 40)% ⇒ pro∈(0.2 ÷ 0.4) ∧ con ∈ (0.6 ÷ 0.8) - reconnaissance data have a large chance not to be a truth;

P∈(0 ÷ 20)% ⇒ pro∈(0 ÷ 0.2) ∧ con ∈ (0.8 ÷ 1.) - reconnaissance data is not a truth.

In [Mammadov V., Bayramov A., 2019, p.71] the evaluation of reconnaissance experts' data accuracy had been offered by taking into account ~~of~~ the comparison of other data connected with the same theme, of the correspondence with the same field experts' evaluations (opinions) and source reliability [Mammadov V., Bayramov A., 2019, p.71]. The data are compared by indicated method and the quantitative evaluation (m_s) is offered:

- the correspondence of other data with the same theme: it is ~~corresponded~~ coincident ???(0.9), it is not full corresponded (0.5), there are no other data (0.3), it is not corresponded (0. 1);

- the correspondence of common conceptions of the same theme to given one: it is corresponded (0.9), it is not full corresponded (0.5), it is not corresponded (0.1).

For the purpose of the classification of reliability of information source (M_e) in accordance with the above-indicated categories and use in calculations, the quantitative evaluation of source properties (m_x) is offered (4). It should note, that such properties as the much data likeness or contradictions among various reconnaissance sources, also the inadequacy of data to source possibilities create a base for ~~misgivings~~ incorrect results.

In addition, the taking into account of information entropy and calculation is reasonable. The determination of reconnaissance data entropy is offered calculating ~~by~~ in accordance with Claude Elwood Shannon theory [Mammadov V., 2019]:

$$\boldsymbol{I_A} = H(A) = -p_1 \log_2 p_1 - p_n \log_2 p_n \quad (6),$$

Here: H– is a Shannons' entropy, A – is an event (state), p_n – is a event (state) probability.

The Shannons' entropy defines quantitatively the reliability of transferred information and it is used for calculation of the value of data uncertainty. The much-gathered data the much extensive information about event (state), thus data uncertainty is decreased. It is naturally enough. By determining an information entropy about any event (state), it can be concluded about data accuracy. When entropy calculating, it should tak~~inge~~ into account other data and possibilities (probabilities). The much close given data entropy to zero the higher data accuracy [Mammadov V., 2019].

In accordance with above indicated comparisons, the quantitative evaluation, summing and taking into account of entropy of the obtained reconnaissance information, the calculation of data accuracy (M_d) is offered:

$$\boldsymbol{M_d} = \frac{\sum m_s}{s} - I_A \quad (5),$$

Here, s – is a number of comparisons, I_A – is data entropy.

W. Platt had offered to divide an information source reliability (M_e) into categories [6]. In addition, for the purpose of use of an information source reliability in calculations, the quantitative~~ly~~ evaluation is offered: the full reliability source – 0.9; the usually reliability source – 0.8; the enough reliability source – 0.6÷0.7; every time not reliability source – 0.4÷0.5; not reliability source – 0.2÷0.3; impossible to determine a reliability of source – 0.1.

As it is mentioned above, W. Platt had offered to divide data accuracy by categories [Platt W., 1997]. In accordance with the above-indicated rule (1), calculations have been carried out. Obtained results are offered as follows: (0.9) - data accuracy are approved by other sources data; (0.8) - data are truth

with much probability; (0.7) - perhaps data are truth; (0.5÷0.6) - data are shady; (0.3÷0.4) - data are not truth; (0.1÷0.2) - it is impossible to determine data accuracy.

Thus, it is advisable to apply the method of quantitative evaluation of reconnaissance data accuracy in processing of reconnaissance data and taking into account during determination of information accuracy.

4. THE SIGNIFICANCE OF INFORMATION

The significance of information (I_d) is evaluated by taking into account of the level of reconnaissance information and its variation with time. The reconnaissance information is divided into below categories: operational-tactical; strategical, information about relatively invariable objects (terrain). The signification of reconnaissance data of operational-tactical and strategical categories is various in periods of war, cease-fire and peacetime. For many cases, the information gets old and losses ~~a~~ significance. For example, the operational-tactical information losses a half signification during 6 hours after obtaining. The strategical reconnaissance information in war period losses 10% of signification in one month. On the other hand, the reconnaissance information about roads, bridges, etc., losses half of signification during 6 years after obtaining [Platt W., 1997].

Let us suppose that even in cease-fire period, the indicators can be changed: the operational-tactical reconnaissance information can loss 5% of signification per one day, the strategical reconnaissance information can loss 5% of signification per one month (table 1).

Table 1. The loss of information signification.

Information category	Periods	The norms of information loss
Operational-tactical information	*War*	10% of signification losses per one day
	Cease-fire	10% of signification losses per one day
	Peacetime	10% of signification losses per one month
Strategical information	*War*	10% of signification losses per one month
	Cease-fire	5% of signification losses per one month
	Peacetime	20% of signification losses per one year
Relatively invariable objects information	*All periods*	10% of signification losses per one year

Taking into account the above indicated, the significance of information has been offered to calculate as next:

$$\boldsymbol{I_d} = D_g - \left(\frac{D_g \times n}{100}\right) \qquad (7),$$

Here: D_g – is a percentage of the information significance for the given day, month or year, n – is the norm of information significance loss.

It is important to calculate and to control an information significance, because corresponding norm its loss directly to impact on the information accuracy. Therefore, it is mandatory taking into account of the information significance during determination of the information accuracy.

5. DETERMINATION OF INFORMATION ACCURACY

Quantitative calculation and control of information accuracy, repeated determination of the tasks for improving this accuracy (if the accuracy decreases) lead to rationality use of reconnaissance power and means [Mammadov V., Bayramov A., 2019, p.66]. If taking into account of above indicated factors, it is

possible the determination of information accuracy in real time. The information accuracy (I_{dq}) can be calculated taking into account a source reliability, data accuracy and loss of information signification:

$$I_{dq} = M_e \times M_d \times \dot{I}_d. \quad (8)$$

The information accuracy, as the result of calculations, is offered classified as below:

1) 85% ÷ 100% - definitive exact information;

2) 65% ÷ 85% - exact information;

3) 50% ÷ 65% - doubtful information accuracy;

4) 25% ÷ 50% - imprecise information;

5) 0% ÷ 25% - definitive imprecise information.

If the accuracy of gathered and stored information reach ~~to~~ critical 50% ÷ 65% level, then a more precise definition have to carry out.

Example. In war period from the reliable source at the yesterday evening "In 18.00 at the evening one enemy's rifle battalion was contacted near the Garadash mountain" current operational-tactical reconnaissance information is truth with very high probability. Let us calculate the obtained information accuracy at the 18.00 today evening.

First of all, let us determine initial indications corresponding to obtained data:

- there is ~~the~~ enough reliable source - M_e = 0,7;
- there are reliable data with high probability - M_d = 0,9;
- there is operational-tactical reconnaissance information (war period, 1 day last) - $\dot{I}_d$ = 90%.

Then, based on the (8) formula the next result has been obtained:

$$I_{dq} = 0{,}7 \text{ x } 0{,}9 \text{ x } 90\% = 56{,}7\ \%.$$

The obtained information accuracy at the 18.00 today evening is 56,7 %.

Thus, at the present, this information accuracy is doubtful. It is necessary iteratively to check this information or to get a confirmation from other sources. There is one more conclusion from this example: in war period, each day the reconnaissance data must ~~be~~ get renewed.

By applying this method and keeping the accuracy of gathered, used and kept information under control, at decision-making time the tasks for reconnaissance power and means can be determined for these data elaboration and checking, As a result, the reconnaissance power and means will be rationality used.

6. CONCLUSION

Thus, during the reconnaissance data processing, the calculation method of reconnaissance information accuracy has been offered taking into account ~~of~~ the source reliability, determination of the reconnaissance data accuracy and the loss of information signification. In the combat region, obtained from reconnaissance groups and other sources, used and kept information accuracy the determination method based the reconnaissance power and means can be more rationality used. It increases an effectiveness of reconnaissance data processing. It is advisable to create a special software for automatization of reconnaissance data processing.

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