

APPLICATION OF MULTI-CRITERIA DECISION MAKING SYSTEM FOR THE TASKS OF THE COMMAND AND STAFFS IN CAMPAIGN OPERATIONS

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Abstract: *With the strong development of science and technology, especially information technology with outstanding achievements in the digital area, there have been strong impacts on the fields of social life. In the military field, especially in campaign operations, the application of new achievements, with smart and modern products, has contributed to the competitive strength of the military forces of countries. From the reality of the characteristics and the mission requirements of the campaign operations commander, the paper proposes the application of a decision-making (MCDM) system to support the work of the commanders and staffs to improve high quality, effective advising and campaigning operations, to meet the requirements of national defense tasks in the new period.*

Keywords: MCDM; Campaign; Operation; Industrial Revolution 4.0.

1. THE MULTI-OBJECTIVE PROBLEMS

The fourth industrial revolution with outstanding achievements in the fields of digital, physics and biotechnology has had a strong impact on all aspects of social life. In the military field in general, campaign operations in particular and the impacts from those achievements, especially in the field of information technology, have made a big breakthrough in improving the effectiveness of operations. Battle meets the requirements of modern wars. In operations of the command and staffs, the application of information technology helps commanders and staffs to change methods in order to handle them quickly and accurately to create favorable opportunities for campaign operations. In particular, by combining the information, campaign conditions and campaign principles of Vietnamese military art, the knowledge of military art experts will help the commander to have a holistic view and assessing the strengths and weaknesses of each proposed operational intention. With their talents and experience, the commander will choose the most effective plan, defeating all combat methods of the enemy.

In this paper, we will present an application model of the problem of multi-criteria decision-making in application of campaign operations. The application system of MCDM's problems is an important and effective software application at the campaign headquarters, the support system for commanding and advising activities for instructors of commanders and staffs in the stages of campaign operations.

In the problems to support the commander and staffs, we select the problem of the commander in choosing the determination of campaign operations, while also introducing the approach to use the MCDM system. On the basis of the PROMETHEE [9] approach, the application system of the MCDM model will give the results of evaluating the strengths and weaknesses based on the ranking points

of each proposed plan. In fact, the problem is modeled in accordance with the rating based on operational principles, weights, and the overall rating for each proposed plan.

2. APPLICATION OF MCDM FOR CAMPAIGN OPERATIONS

An MCDM model is the model class in the theory of decision support model. The most important characteristic of this model is that there are many objectives, points of view based on the principles of combat, the requirements of the commanders, and they often conflict with each other, bringing the characteristics of the an multi-objective optimization problem. The commander not only wants the best plan, he also wants the system to make assessments of strengths and weaknesses for other plans. For example, with each proposed operational plan, on the basis of its content including: identifying targets, organizing forces, using firepower, electronic warfare..., the commander does not just want to quickly achieve operational objectives, but also how well they want content components, especially adherence to combat principles, suitability, and effectiveness in dealing with enemy tactics, the area of the battle area, ... It is the reference information, or the interest of the commander to choose the final battle plan, with the selected bases that the system provides.

The process of applying the MCDM model includes the following basic steps:

- Step 1. Determine the decision problem.
- Step 2. Define the objectives of the problem.
- Step 3. Gather the proposed plan.
- Step 4. Model the objectives.
- Step 5. Determine the weight of each objective.
- Step 6. Select the appropriate MCDM model.
- Step 7. Apply the selected MCDM model.
- Step 8. Estimate the results.

The steps taken for the problem of supporting decision-making in choosing a campaign plan are described as follows.

2.1. Determine the decision problem

The problem of supporting decision selection in choosing campaign (determination) campaign is considered with the basic contents of determination, in this paper, the author assumes some theoretical content. The conventional theory is that $ND = \{nd_1, nd_2, ..., nd_n\}$ corresponds to the content of components (from 1 to n components) of the campaign determination, according to the theory of military art theory of Vietnam. Each plan will have value for each different content, respectively $V = \{v_1, v_2, ..., v_n\}$ forming the decision space with n dimensions. Based on the knowledge base modeled into conditional logical relations in the

form of cause-and-effect results, we will test and evaluate the efficiency through the values of V_i for the objectives $M = \{m_1, m_2, \dots, m_k\}$ of the problem. In which, m and k are not necessarily equal.

2.2. Determine the objectives of the problem

In order to evaluate the effectiveness of each plan, the commander determines the objective of the problem, on the command of combat operations. In determining the campaign plan, the common objectives selected are: execution time of component contents, operational force organization (number and composition), enemy-campaign forces correlation,... these objectives are often contradictory, for example: optimization of forces, components participating in combat contradictions in terms of correlation, the ability to defeat enemy combat measures, time to deploy forces. Therefore, the multi-objective optimization algorithm will be an option to determine the equilibrium alternatives between these objectives.

2.3. Gathering the plans

Based on the operational intent, the commander will have a variety of component choices based on the basic content set of determination (ND) with the quantized values of the corresponding set V . In addition, the plans are organized data to include management information, points of interest, extended beyond the content identified in the ND set as a basis to provide the most complete, most specific when present final results.

2.4. Modeling objectives

The main objectives are always complex and can be divided into lower levels called sub-objectives and if necessary, sub-criteria can also be broken down until they can be calculated according to the target value or topic (aggregate function from objectives). Therefore these objectives always form a hierarchy. Building this hierarchy is a relatively complex content and can require a lot of time and experience. Figure 1 illustrates the target hierarchy.

2.5. Determine target weight

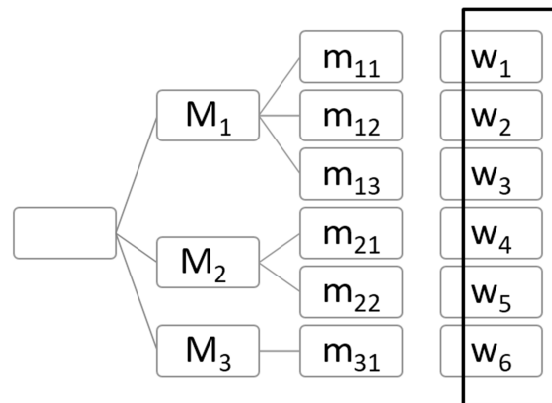


Figure 1. Flexible for determining weights based on the hierarchy of objectives.

There are two types of models for weighting: objectives and subjects. Objective based methods based on the dispersion of plan values belong to the same criteria but they need a lot of data. The thematic methods are based on a paired and systematic comparison that requires experts, in this problem are military art experts, with the knowledge and experience in tactical command. Illustrations for using target weights are shown in figure 1.

2.6. Choose a model that supports appropriate multi-objective decision making

The models that MCDM have different characteristics, choosing which model is actually an optimal multi-objective optimization problem. The most important objectives in this selection are: in accordance with the law organization of the military art knowledge base; desired commanders' objectives: streamlined organization, quick execution time, effectively dealing with enemy combat measures; set of plans and determination expected; sources of information provided for the system: modeled military art knowledge base, experts; Initial information: information about the enemy, the terrain, weather, climate, hydrology.

2.7. Application model to support multi-objective decision making

The problem of MCDM in choosing campaign operation plan, the article proposed for implementation the ranking technique PROMETHEE [9]. In this model, the priority coefficient for each pair of options for each objective will be calculated based on the priority functions but the variables of the function are not the value of the solution but the difference between two options are based on the same objective, so this model records the difference. Formula 1 represents the mathematical model of the priority function and table 2 shows the example weights of the problem. Table 3 shows the priority calculations of the options according to the set weights.

$$U(pl_1, pl_2) = \begin{cases} 0 & |d \leq t \\ d - \frac{t}{u-t} & |t < d < u \\ 1 & |d \geq u \end{cases} \quad (1)$$

In which, U is the priority, u , q are the threshold values, d is the difference in value between the two plans.

Table 1. Target values of a target function (need to be minimized) in the alternative options PL1, PL2,..., PL5.

PL1	PL2	PL3	PL4	PL5
22.3km	36.7 km	28 km	35 km	26 km

The priority coefficients are calculated according to formula 1 using the data in table 1 (Illustrating the maneuver distance of electronic battalions). The threshold

is 0 and 14.8 km, the difference is calculated with $d = - (pl_1 - pl_2)$ because the objective is minimal so the smaller value is better.

Table 2. Priority coefficients of the target values.

	PL1	PL2	PL3	PL4	PL5
PL1		0.26	1	0.4	0.88
PL2	0		0.74	0.14	0.38
PL3	0	0		0	0
PL4	0	0	0.6		0.49
PL5	0	0	0.12	0	

Computation of Unicriterion Flows: Priority matrices are multiplied by their weights and these matrices are added together. The positive flows are calculated by the sum of the composite matrix elements of the rows and the negative flows are calculated by the sum of the elements of the columns. They are shown in Table 3. A rank can be interpreted by positive and negative streams. One plan is better than the other, if the positive current is better and the negative current is smaller than the other.

Compute total flow: The total flow is calculated by positive flow minus negative flow. The result is shown in table 3.

Based on the rating scheme, when we maximize the positive flow and the minimum of negative flow, combined with the total flow will determine the most appropriate plan. The meaning of the treatment is based on the principles of operation, will determine the appropriate points, not consistent with the principles of each objective. The results rank the advantages (according to the positive flow) and the disadvantages (with the negative flow) and with the relative ratings based on the total flow. The results will help the commander to have a comprehensive view of each plan, with his talent and experience to choose the appropriate battle plan.

Table 3. Target Unicriterion and total flows.

	L+	L-	L
PA1	0.556	0.011	0.454
PA2	0.518	0.021	0.497
PA3	0.186	0.306	-0.121
PA4	0.053	0.438	-0.536
PA5	0.041	0.576	-0.385

3. CONCLUSION

The application of MCDM model has become a typical and popular application in applying the achievements of the 4th industrial revolution to military activities. With the advantages and achievements of the research in finding solutions to optimal multi-objective problems, the model of MCDM is a model suitable to the practical requirements of the problem to support the commander to determine the strategy and determination to operate the campaign. The paper introduced the model of decision support method according to the PROMETHEE ranking method to solve the practical problem in the tasks of the commanding and staffs at campaign and strategy level, suitable for modeling capabilities, quantify the operational principles of Vietnamese campaign art, an important component of Vietnamese military art. The application of this model, the development of problems to support the evaluation and selection of campaign operations will contribute to improving the effectiveness of the commander, meeting the requirements of the modern operations.

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TÓM TẮT

ỨNG DỤNG HỆ HỖ TRỢ RA QUYẾT ĐỊNH ĐA MỤC TIÊU CHO CÔNG TÁC CHỈ HUY – THAM MƯU TÁC CHIẾN CHIẾN DỊCH

Với sự phát triển mạnh mẽ của khoa học công nghệ, đặc biệt là công nghệ thông tin với những thành tựu nổi bật trong lĩnh vực kỹ thuật số đã có những tác động mạnh mẽ đến các lĩnh vực của đời sống xã hội. Trong lĩnh vực quân sự, đặc biệt là trong các hoạt động tác chiến, việc áp dụng những thành tựu mới, với những sản phẩm thông minh, hiện đại đã góp phần tạo nên xu thế cạnh tranh sức mạnh của quân đội các nước. Từ thực tế đặc điểm và yêu cầu nhiệm vụ của công tác chỉ huy tham mưu tác chiến chiến dịch, bài báo đề xuất áp dụng mô hình ứng dụng hệ thống ra quyết định nhằm trợ giúp công tác của người chỉ huy và cơ quan trong nâng cao chất lượng, hiệu quả công tác tham mưu tác chiến chiến dịch, đáp ứng yêu cầu nhiệm vụ bảo vệ Tổ quốc trong thời kỳ mới.

Từ khóa: Hệ hỗ trợ ra quyết định; Tác chiến; Chiến dịch; CMCN 4.0.

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