USE OF THE DECISION TREE METHOD IN THE PROCESS OF CREATING VARIANTS OF FRIENDLY ACTIVITIES WITHIN STAFF PLANNING AT THE TACTICAL LEVEL

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ABSTRACT

The military decision-making process (MDMP) plays a decisive role in planning an operation at the tactical level. The core of the whole process is a series of gradually performed activities (phases and individual planning steps), the second phase of which is the creation of variants of friendly activities (Courses of Action -COAs), in which the variants are prepared, analyzed and compared. During the creation of variants of activities, the staff (designated teams) prepares various variants which are then analyzed and compared. The aim of the preparation of variants is to determine one or more variants to accomplish the combat task (objectives of the operation). The variant then represents an acceptably developed plan for the anticipated adversary course of action (ACOA). The authors of the article focus on developing the use of the "decision trees" method in the preparation of variants of friendly activities. The authors attempt to examine the use of this systematic-analytical method for the preparation of variants of friendly activities, where decision-making takes place in several stages. The creation of variants is carried out according to NATO documents with the use of simulation methods, which can be incorporated into the stage decision-making process and used in combination with the decision tree method.

KEYWORDS: decision-making process, variants of activities, preparation of variants of friendly activities, decision tree method

1. Introduction

Decision-making in a military operation represents a process of making choices of several possible courses of action alternatives. The subject (COAs) of decision-making (based on knowledge, analyses and estimation) is to consider given taking solutions, when into account particular criteria. and their mutual comparison. Then it is important to select the most advantageous alternative, risk assessment and take the decision. COAs alternatives represent a possible way of mission accomplishment. Methods of creating COAs are methods of creative thinking. In operations, methods are used which are influenced by a number of factors, especially by the time factor.

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Systematic-analytical methods are the most commonly used ones. These are heuristic procedures, i.e. new creative procedures very often connected with continuous discovery. These procedures require a creative approach. The result is a set of all applicable solutions.

The subject of this article is to analyze and propose the process of creating COAs within the Military Decision Making Process (MDMP) using the systematicanalytical decision tree methodology together with the movie method.

The aim of the article are verified or falsified hypotheses:

a) The methods and content of COA development are sufficiently described in available documents.

b) To increase efficiency of the COAs development, it is optimal to use the decision tree methodology together with the simulation of a particular situation development.

Content analysis of the literature, analysis of the current state of the problem and the use of the decision tree method are used to verify/falsify the hypothesis.

The starting point for meeting the objectives of the article is the Military Decision Making Process (MDMP) carried out at risk (i.e. the available information is incomplete, but the commander is able to specify the probability of individual states of the world, including the probability of their consequences). The approach to the decision making process at risk enables the commander and his staff to formulate decisions in relation to the most likely state of the world and its consequences, and, at the same time, to prepare measures for the emergence of a different state of the world and its consequences.

The assumption is that the commander and his staff implement a complete MDMP (using routine standard operating procedures – SOPs) with the use of the Information System (IS). In the implementation of a complete MDMP the

commander and his planners have the necessary amount of information and developed prerequisites for the commander to be able to identify possible states of the world and the probability of their occurrence.

2. Problem Analysis

The key moment in the process of operation plan development during the MDMP is the development of COAs based on the conclusions of phase 1 – clarification of the situation and the task (task analysis and operational environment factors evaluation).

The goal of creating COAs is to create one or more possible solutions to accomplish the combat task. The COAs development itself is carried out in the 2nd phase of MDMP during considering and developing the COAs and represents its 3rd step – courses of action (COA) development. When creating COAs, the staff planners work on the assumption of several aspects: the mission tasks, the conclusions of the operational environment factors evaluation (which are constantly updated), the commander's intent and his planning guidelines (setting the framework, limit and screening criteria), the conclusions of the Intelligence Preparation of the Operational Environment (IPOE), the ordered (specific and additional) tasks and the anticipated adversary course of action (ACOA). In the phase of developing friendly COAs, planners must constantly respond to the identified activities of the adversary and constantly verify the activities of friendly units. During the COA development, process products such as task definition, commander's intent, planning guidelines, as well as many other different acquired products created during task clarification and analysis are used. The COA development also includes the application of operational and tactical art.

The commander's immediate involvement in the process of COA development greatly helps create a complex and flexible COA in the available time. The commander may limit the number of COAs or specify which COAs not to deal with (this fact is taken into account when announcing the limit criteria) (Černý & Pitaš, 2021).

The resulting variants should always be a logical product of the previous process and should represent a sufficiently elaborated plan for the anticipated adversary course of action (ACOA).

The individual COAs development itself is based on the successive activities of planners in teams. Each of the teams performs step-by-step activities, which include relative combat force analysis, brainstorming, task organization (TASKORG), concept of unit maneuver, setting the command structure, and creating both written graphical form of the and COA. Subsequently, a COA briefing is carried out (in accordance with the work plan at the command post and the commander's clarification), where the COA is selected.

When analyzing combat strength, planners evaluate the available data and information concerning all means of destructive force and make a rough estimate of the maneuvering units' coefficient – 2 levels down to the equivalent of the enemy's maneuvering forces. Then a comparison of the strengths of friendly troops and the weaknesses of the enemy is made, and vice versa. This is done for each element of the combat force. From this comparison, it is then possible to identify the vulnerabilities of each unit, or whether it is necessary to provide protection against threats coming from the enemy.

Subsequently, the brainstorming is performed. The brainstorming begins by creating a decisive operation. The planners check out whether the decisive operation fits into the superior level operation concept and, subsequently, they go through the process of shaping the operation and elaborate tasks to maintain combat strength in the decisive operation as well as in individual tactical activities (Sustaining Operation).

When TASKORG for a specific COA is set, the planners determine the essential tasks for each shaping and sustaining operation, create options for each COA, check out each COA to see if it meets the screening criteria. Not only a preliminary determination of the force ratio is enough to TASKORG, but the decision is set influenced by a number of other factors (e.g. consequences of previous battles, quality of command and control, morale, current state of equipment and vehicles, available time, and last but not least, level of electronic warfare, logistics, fire support, direct air support, civil support, and many other factors). The units form up to 2 stages and the initial formation is focused on basic ground maneuver units (regardless of the type specification or task force).

The formation of the unit maneuver itself describes how the units will perform tasks according to the commander's intention. It is a brief statement of the commander's idea of "HOW?" and a framework for the Concept of Operation (CONOPS). CONOPS is the basis for combining all combat and non-combat activities. The planners prepare the concept of a unit maneuver for each COA both in written and graphical forms. Lines of operation, which represent the connection between the objects – decision points – the focus of the operation, and the lines of effort, which combine the tasks with the aims - objects - the final state of the operation are used to create the concept. Subsequently, the planners determine the Command and Control (C2) structure, which is created based on the pre-set TASKORG.

A text description and a graphic drawing are processed for each COA. The text simply describes how the unit will accomplish the task and what combination of forces and resources will implement the concept. The drawing provides the movement and maneuver aspects of the operation concept, including unit positions. The text and the drawing together express – WHO, WHAT, WHEN, WHERE and WHY – for each TASORG element.

2.1. Literature Analysis

The basic precondition for choosing the approach to COAs is knowledge or ignorance of a set of problem-solving alternatives and, consequently, knowledge or ignorance of procedures and methods for creating the variants (Fotr, 2010). The commander (the decision maker) mostly works with poorly structured problems, when he is not familiar with COA solutions, but he has access to clearly formulated procedures for creating COAs and simulation methods to verify the consequences of the created variants of activities. For this reason, the authors further limit themselves to creating variants of solving poorly structured decisionmaking problems with knowledge of variant creation procedures.

Intuitive and systematic-analytical methods are used in the process of solving poorly formulated decision-making problems to create variants of activities. (Grasseová, 2013) An important factor for choosing a method is the time available to the decision maker. In case of lack of time, intuitive methods (brainstorming, brain writing) are usually used. If the decision maker has enough time, it is recommended systematic-analytical to use methods (synectic Gordon method, morphological analysis or decision tree method). The number of members of the group that makes up the COAs also plays an important Morphological analysis and the role. decision tree method are suitable for up to 5 people in a group while synectic Gordon analysis is suitable for 5 people and more. Another important factor is the qualification of all group members and their knowledge of the problem. If there are experts in the group with good knowledge of the problem, then it is appropriate to use a decision tree or morphological analysis. If there are group members with a low level of knowledge and expertise, it is appropriate to use the synectic Gordon method (Fotr, 2010). The group which formulates COAs for the commander (the decision-maker) has enough time to create variants within the decision-making process during the complete planning process implementation. Due to the low number of members (up to 5 people) and the fact that they are military experts, the decision tree method and morphological analysis can be determined as suitable methods for the creation of COAs

Morphological analysis is based on the systematic structuring of elements of the decision-making problem, segmenting into partial problems, finding possible solutions to these problems and their mutual combinations. The created combinations then become individual variants to solve the decisionmaking problem (Fotr, 2010; Grasseová, 2013). The basis of morphological analysis is the definition and analysis of the identified components factors (a decomposed problem) and setting their values. An essential condition to define the factors is their logical independence. However, the environment (combat planning), which COAs are created for, contains factors that are logically dependent. The task is also staged and COAs are created for each stage of the task. Since the method is very time-consuming, it is suitable for single-stage decision-making processes only. The logical dependence and unsuitability to be used for a multi-stage decision-making process is the reason why the morphological analysis is not suitable to be used to create variants of activities (to fulfil the combat task).

The decision tree method is a method which is used to display and support the solution (creation of variants) of multi-stage decision problems. Decision trees show possible COAs, risk factors, development – including where these risk factors are located and the impacts of COAs (Fotr, 2010; Grasseová, 2013). The method is based on graph theory, where it shows:

-decision nodes, from which the edges presenting the decision variant;

-situational nodes and edges presenting situational variants emerging from them. Situation nodes with the situational variants' edges show possible values of risk factors, or values of consequences of

decision-making variants for individual risk situations (risk scenarios) (Pitaš & Crhák, 2016).



Figure no. 1: Decision tree (two-stage decision-making process) (Source: Fotr, 2010)

The decision tree in Figure no. 1 presents the variant formation under the terms of a two-stage decision-making process. The decision in node A presents two COAs (V1, V2), which enter the situational nodes B and C. Situational variants (S1, S2) presenting the possible impacts of variant V2 emerge from the situational node. Situational variants are ended by decision nodes D and E. Two COAs V3 and V4 ended by situational nodes F and G emerge from the decision node N. Risk factors S3 and S4 emerge from the situational node G. If the decisionmaking process involves several stages and thus could become confusing, it is possible to use more decision trees for a more appropriate presentation.

Although Fotr (2010) points out in his publication the interconnection between decision trees and simulation, he deals with this only in relation to risk analysis (risk scenario and its probability), including its impact (Monte Carlo method). This simulation is not suitable for use in the commander's planning and decision-making processes, as it only works with quantified risks (probability, impacts). However, the simulation based on the Monte Carlo method can be replaced by a simulation based on risk management according to the order of the Minister of Defense No. 20/2018 of the Bulletin. The basis of this order is a qualitative analysis of assets (availability/reparability or substitutability), the effect of threats (intent or determination/strength of influence) on the weaknesses of the asset with subsequent identification of risk scenarios and their impacts.

The analysis of the literature showed that for the environment of combat tasks accomplishment planning and forming the COAs, it is appropriate to use the method of decision trees (time-consuming, multi-stage decision-making). The connection of decision nodes, COAs with situation nodes and variants of possible situations (risk factors) indicates the possibility to connect the method with the simulation method (simulation of possible situations based on COAs).

2.2. Analysis of Professional Military Literature

Based on the goals of the research problem, the intention of the literature search on the given issue was to create an overview of current available knowledge at the Alliance (NATO) level and in the

national environment (Army of the Czech Republic – ACR). To create a critical overview of current knowledge concerning the problem, the authors focused on the following alliance and national resources: ATP-3.2.2 – Command and Control of Allied Land Forces (2019), APP-28 Tactical Planning for Land Forces (2019), Pub-100-53-02 Command and control of the allied ground forces of the Army of the Czech Republic (2020), SPG-3-44/Oper Methodology of work of the brigade staff in planning operations of the Army of the Slovak Republic (2012), selected standard operating procedures (SOP) from the ACR brigades and combat battalions.

ATP-3.2.2 does not elaborate on the content and planning process at the tactical decision-making level. The process, including the preparation of COAs, is presented in its subchapter 0410 _ Operational-Level Planning Process (OLPP). The ways and methods of creating COAs are not discussed in this document. APP-28, content of which is the process of land forces combat planning at the tactical level, describes the creation of COAs (from the point of view of the issues addressed in the article) in the most detail. Chapter 2, in the general provision, defines the creation of variants as phase 2 of planning and – preparation of variants. step 3 The preparation of COAs is elaborated in detail in Chapter 3.1. The content of this chapter elaborates on general provisions concerning the initial conditions which are necessary to create COAs (combat task, commander's intention, IPOE conclusions, and the factors evaluation), as well as the objectives of the preparation of variants and characteristics. Subchapter 3.1.1, COA called "Choose a COA Development *Method*". states: "*There are several suitable* methods for creating variants. Some planners envision a sequence of actions, the purpose of which is to achieve a set of goals, while others consider ways to encounter the adversary's most likely actions". This is

followed by a list of individual activities and their description (where the planners find important to assess relative combat power, generate options, establish operational framework, array forces, assign tasks, develop the COA's statements and sketches, validate the COAs, deliver the COA briefing and select or modify the COAs for continued analysis). Specific variants preparation methods are listed and briefly explained in subchapter 3.1.3 "Possible COAs", where it is stated that in order to create variants, the following methods can be used: brainstorming, movie-method or war-gaming. The Czech Army Military Publication Pub-100-53-02 (p. 96) states that each COA should consider the ratio of available and required units to fulfil the task, taking into account the purpose of the operation and the identified main effort. It is further stated here that the advantages and disadvantages of each COA are considered in relation to the (combat) task and the anticipated adversary's COA. The text of this publication also states that a COA that is not in accordance with the commander's intention is not being further developed. Nothing is stated here about the way (use of the method) of preparation of COAs.

"Service aid _ SPG-3-44/Oper (pp. 20-21)" of the Army of the Slovak Republic does not develop the way (method) of creating COAs, it only focuses on the fact that the processing of COAs consists of the continuation and expansion of staff analyses, aim of which is to develop the maximum possible number of COAs to allow more flexibility. The publication also states that the overall picture of the adversary's activities and friendly forces is gradually being created. Envision concerning possible composition and use of individual battalions and units, their division into echelons, direction (axes, corridors) of movement, approach directions, lines of deployment, commitment areas, and combat tasks can also be found in this publication.

The authors of the article analyzed selected SOPs from two brigades and two battalions of the ACR. The level of elaborating and forming the COAs is practically the same at all analyzed subjects. The SOP content does not include any specific ways or methods of creating COA. There are exactly specified individual steps (activities) which the processing teams should follow (determine the amount of forces needed at the end of the operation, their formation, area of deployment, draw the situation on the foil; determine the best way to recover the units from the area where the operation was terminated to the initial area; draw all the tasks that the departments and units will gradually perform "on their way" to the area of termination of the operation in the diagram; determine and add to the diagram the arrangement of the operational formation and the way the formation will be taken up; determine the basic requirements for the forces deployment in their friendly area and the tasks they will have to accomplish in order to take it up; assess whether the composition and organization of the forces is sufficient to accomplish all tasks; identify and add other measures and data - e.g. to maintain the abilities of the forces, provide command and control; temporal and spatial calculations and others). Next, questions that each COA must answer are elaborated (e.g. what type of military operation it is, why the operation is carried out, how the operation will be carried out, what main tasks and in what order must be accomplished, who will take part in the operation, when the operation will be launched, where the operation will take place, the order in which the forces will be deployed into the operational formation, how abilities of the forces will be maintained during the operation, how command and control will be organized, and so on). The analysis of the selected literature leads to the conclusion that the available documents efficiently describe neither usable methods nor the content of COA formation.

3. Discussion

Based on the available literature review conclusions (see 1.2), it is clear that the methods of creating COAs and their effective use are not sufficiently developed and described (except for their list in APP-28, 2019). The list of steps describing the creation of variants defines only the content and focus, however does not provide the answer to the basic question "HOW". Based on the above stated fact, it can be said (1st hypothesis) that the methods and content of COA formation are not sufficiently described in the available documents. The hypothesis is falsified.

It is necessary to elaborate on the method of decision trees and its application in the decision-making process into national documents and standard operating procedures. The use of the decision tree method when creating the COAs in the individual stages of the task would allow the planners to depict the course of individual phases of the combat. With this illustration, it is possible to guide the individual planning teams to understand the possible development of each COA and, at the same time, to define at least 2 decision variants or 2 situational variants for each decision variant. Applying this method will prevent the creation of only one variant of the solution or the only situational variant. The use of the decision tree method should be further extended by the use of the brainstorming method. It is the correct application of the creative method of brainstorming that complements the method decision trees with the creative of of possible identification variants and situational variants.

The creation of COAs is supported by the flow of information in the command and control information system, the display of information and its further processing (textual and graphical), including the performance of some analyses based on map data (visibility, etc.). The information system does not deal with the use of COA creation methods. This is fully left to the

commanders and their staff, their ability to evaluate information and further process it (depicting and creating written documents into templates, graphic documents, etc). support Further in the form of incorporation, e.g. the use of the decision tree method, is lacking. It is possible to incorporate the method in software (creation of variants and situational variants of the stage, including links to the next/ previous stages). The incorporation of the method should be carried out in accordance with national documents and standard operating procedures.

In the Army of the Czech Republic, the war game method is often used to simulate the development of the situation. The method is applied to verify the selected COAs. The movie method mentioned in APP-28 (2019) is a simulation method, where, based on a variant of the decision, we let the situation run like a movie. The course of action is analyzed and subsequently evaluated to identify the strengths/weaknesses of the variant. The simulation of the expected situation development is supposed to confirm/ disprove the decision. The movie method is a suitable method for the command and control system, because information technologies are able to create such a movie and play it based on specified parameters (both positive and negative). Subsequently, information technology can interconnect the decision variants in individual stages and continuously replay the development of the situation stage by stage. This interconnection will allow to complete the overall picture of decision-making process (selected the variants of stages).

The hypothesis, saying that it is optimal to use the decision tree method in combination with the simulation of the situation development in order to increase the efficiency in the preparation of variants, has been verified.

4. Conclusion

The implementation and use of the systematic-analytical method of decision trees in the military decision-making process at the tactical level is suitable for the identification of variants of activities at individual stages of task accomplishment. The fact that none of the methods is incorporated into national documents and standard operating procedures (no elaboration standardization of NATO documents. e.g. APP-28) shows a lack of understanding of how important these methods are. It is not possible to rely solely on the commanders' skills and their staff. They need to be supported by these documents in their decision-making process purpose of which is to successfully accomplish the task.

The command and control system provides information support (data flows, creating information - written, graphic). Information technologies as a part of this system have the ability to perform the necessary analyses and simulations. For this reason, it is possible to incorporate both the decision trees method and the movie method which will further enhance the capabilities of the commanders and their staff in identifying the COAs and verification simulating the of the correctness of their decisions at individual stages. The benefit of using information technologies (application of meta decision trees, movie method) is the success in task accomplishment.

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