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OPERATION RESEARCH IN THE DECISION MAKING PROCESS AND LOGISTIC SUPPORT PLANNING

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Abstract: *This paper is a contribution to a further development of logistic support and planning of the Czech Armed Forces. Main idea is to promote and deliver a proper operations research framework into the operations planning process and into the entire environment of military missions and operations. From the point of view of the decision making process the Czech armed forces widely employ empiric approach and on site solutions. This paper promotes scientific methods to the system of logistic support enabling the army to operate both effectively and economically. Our proposal includes a research of mathematical methods and heuristics being used by NATO countries and/or in the civilian sector. Integrating such methods into the military decision making process chain may largely contribute to support fundamental decisions in a more accurate and sophisticated way with potential economical side effects.*

Keywords: *operation research, decision making, logistic support, planning*

1 INTRODUCTION

Paradigm shift in the North Atlantic Treaty Organisation´s (NATO) and the European Union´s (EU) security and defense policy, comes along with new challenges and tasks for the armed forces (AF), while making it necessary to modernize and reform logistics systems. Limited budgets require military commanders to implement economic austerity measures at all organizational levels and among all activities. The Military Strategy of the Czech Republic mentioned the need to achieve greater efficiency especially in logistics. Efficiency goes together hand in hand with right decisions. The NATO-standard operational decision-making process (ODMP) clearly provides a complex framework to enable proper decisions to be made. However still only few NATO countries employ a skilled operations research (OR) staff to carry out more advanced analytic and evaluation methods and procedures. This paper outlines some ideas considering certain improvement possibilities for the decision support and planning.

2 SYSTEMS FOR DECISION SUPPORT

The systems for decision support include a wide variety of models, simulations and other software applications that are designed to facilitate and improve decision making. These systems simulate various operating environments and may include conditions of uncertainty and analysis of "what happens, when ..." used algorithms or heuristics. [1]

The decision support systems, which may include decision analysis systems, predictive models, simulation models or linear

programming models, can integrate tools of the artificial intelligence. [1]

2.1 Using the simulation for decision support

The simulation is a method that creates models of the situation and may determine the likely changes that occur during the implement of an alternative or a change of variable. [1]

The computer simulations allow users to overcome the problems of implementation of dynamic programming module random effect and the need for a large number of calculations. The computer simulation can be characterized as the display of the behaviour of the real object on the computer. Using simulation provides many advantages such as the simulation time can run faster than real, so it is possible to evaluate a large number of alternatives [2] and the cost for changes of the test options are a fraction of the cost than if the change was implemented in the process.

Computer simulation is only a tool for decision support and can not find an optimal solution of the problem. Decision-maker must change the structure of the system, changing the variables that can affect the real environment and using model chooses the best combination of the variables. [3]

For the correct functioning of the application of simulations is observed these follows rules [3]:

- knowledge of the modelled object or process;
- effectiveness of the design;
- collection of the necessary information;
- identification of the variables;
- review of the changes that occur in the real system.

For computer simulation is possible used countless of the software applications, as well as spreadsheets (e.g. MS Excel).

2.2 Supply Distribution Model – software application designed for the computer simulation for decision support

In the process of planning and the various stages according to the requirements are presented information and intentions of in logistics assessment and analysis of the options activity. The planning process is always directed to accept of the decision and issued tasks to subordinates.

During the planning process is prepared necessary documentation for the organization and management of logistics support. The decision making and the planning processes are running concurrently, in which authority and logistics commander thoughtfully prepare future operation and logistics support of this operation. [4]

The part of logistics information system of NATO LOGFAS (Logistics Functional Area Services) is a simulation tool for decision-making support in the supply process. This is SDM (Supply Distribution Model), which allows test and simulate the situation for the replenishment of the generated scenarios, identify bottlenecks and other problems in the supply chain, and then analyze the outputs. The scenarios that are created for modelling supply chains, based on defined parameters and factors that affect the calculation of the inventory.

Using SDM in the process of planning and decision-making is shown in Figure 1.

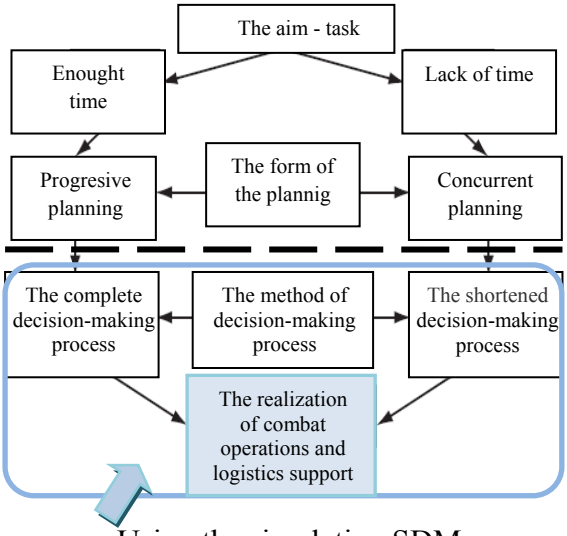

Figure 1 planning and decision-making process with the involvement of SDM

In the decision-making and planning process are prepared the alternative solutions of logistics support. These options can be used to test and evaluate SDM simulation outputs. Supply Distribution Module provides two types of outputs. One of them is the indicator of inventory when inventory items do not fall to below Reorder Level or on Zero Level.

This information can be read from graphs or Shortfall of Commodities Report. The second indicator is the capacity utilization of transport assets. This information is provided by the Transportation Asset Utilization Report. It follows that the simulation of SDM is the support for decision making; it is shown in Figure 2

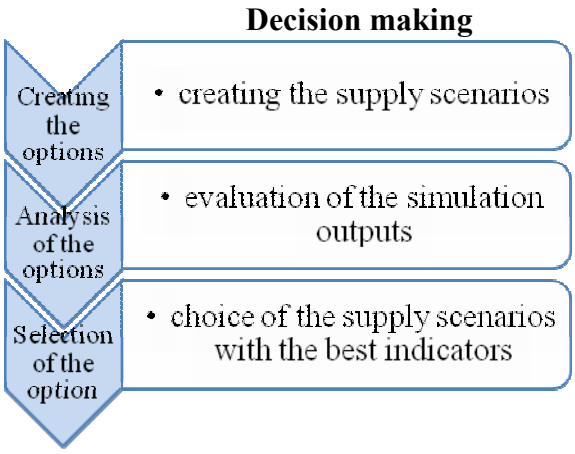

Figure 2 Scheme decision making for supply

The advantages and the disadvantages are assessed for each option. The Pre-established criteria and priorities can be used of selecting the best solution. In the process of comparing alternatives is possible to use a variety of methods, such as the method of weighted correlation tables. The evaluation of criteria is relatively objective expressed in terms of numbers, which are the result of subjective assessment. For each numerical expression of the value criteria is assigned so-called the weight. [4]

Supply Distribution Model can be used as a support tool in planning and decision making in the phase of preparation operations, but also during the operation. When working with a model during the operation it is possible set, edit and change the input parameters and evaluate the situation - "what happens, when ...".

It is possible to test events that occur with a probability based on developments in the area of operation. From the simulation outputs is possible to adopt measures that would mitigate the adverse impact on the entire supply chain.

2.3 Finding the entry point for operations research methods

Optimization effort is a logical result of efforts made to more efficient spending of resources, especially financial, and working time. If a better solution than the current one is found, it is possible under given conditions to maximize logistical support.

The ODMP is taught to officer cadets of all military services in many nations, including the Czech. It is designed for hierarchical organisations, clear goals, and rational decision makers. Characteristics of the ODMP are [5]:

- It emphasises the planning process before an operation begins.
- It assumes a hierarchical organisation.
- It is a successive, top-down decomposition process.
- Planning at each level of decomposition is largely linear; see Figure 3.
- Planning at any given level can only begin when planning is complete at the next level up.

Warning orders allow some overlapping.

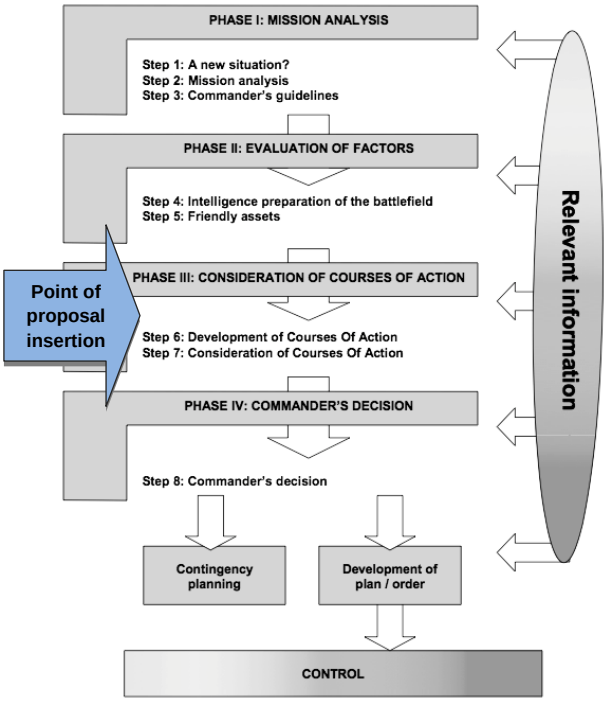

Figure 3 NATO-standard operational decision-making process

Czech army does not systematically employ OR specialists even on a strategic level. The whole ODMP as shown above is typically run according to doctrine however with only standard tools relating to decision-making such as risk and centre of gravity analysis and limiting factors evaluation. Phase 3 of the ODMP is an ideal time for OR implementation (assuming trained and skilled Operations Research/System Analyst (ORSA) with appropriate knowledge of military logistics).

In US Army the ORSA, Functional Area 49 (FA49) for military, Career Program Series 1515 for Army Civilians, is a science professional who produces analytic products (e.g. decision aids, models) to underpin decisions by Commanders and to enable solutions of varied and complex strategic, operational, tactical and managerial issues. ORSA personnel use quantitative and qualitative analysis throughout the decision-making process. ORSA personnel are adept at problem solving, identifying risk, and communicating results and recommendations. Some of ORSA´s Unique activities:

- Data analysis;
- Decision models;
- Nodal or flow modelling;
- Qualitative assessments;
- Probability assessment;
- Trending and forecasting;
- Geospatial analysis;
- Effects assessment;
- Logistic support analysis.

ORSA techniques help to allocate scarce resources, and to prepare, plan, analyze, and assess operations. [6]

Project management implementation:

All military plans consist of a certain time scale. There is chain of activities to be done subsequentially or simultaneously each with duration. There is a deadline as well. For a reasonable decision-making a time management is something not to be omitted. The Critical path method using a Gantt chart is one of a many possibilities how to plan and watch your project. The Program (or Project) Evaluation and Review Technique, commonly abbreviated PERT, is a statistical tool, used in

project management, that is designed to analyze and represent the tasks involved in completing a given project. Knowing the likelihood of a project (or a plan) being finished in a certain time might be a strong argument in COA decision briefing (ODMP phase 3).

Optimization of supply chain in the area of operation:

It can be viewed as an effort to find the best distribution solution. The level of logistical support generally depends on time and resources as key factors for optimization. The Operational Decision -Making Process (ODMP) should include an appropriate design of an optimal distribution model before the courses of action are presented to the commander. In case the distribution dependent system components are stationary (e.g. bases, security stations) the so-called ex-post optimization has to be put into consideration. If the system elements are movable (e.g. new operation) from the point of view of distribution strategy optimization the OR provides two applicable methods:

- Method for optimal distribution system structure (Object Localization models – e.g. distribution centre localization);
- Method for transportation routes optimization (Optimal distribution chain between system elements – typically Travelling Salesman problem).

The result of an optimal placement of the distribution centre (DC) is an area defined by boundary lines. That particular area shows where the cost function is minimized - the cost of potential supply will therefore be minimized. As mentioned above, the deployment of this model must be preceded by consideration about how the distribution will be done. Whether supply will be transported on roads or, for example air (mostly straight line flight – e.g. helicopter dropping material). This decision will set conditions for the problem formulation.

Optimal distribution chain between system elements:

If it is not possible for any reason to use the services of a distribution centre (typically the deteriorated security situation in the neighbourhood), it is essential to find another way to supply. Usually it is necessary to get along with a limited transport capacity. For an optimal distribution chain in some cases a Traveling salesman problem (TSP) might be employed. The problem belongs to the category of Non-linear programming with a typical computational complexity.

Clearly there are other various OR methods or special heuristics which have a potential to be involved in the ODMP.

3 CONCLUSION

Together with the rise of importance of simulations provided by the SDM module the OR research methods mean a real challenge for the planning staff. The authors propose the ideal theoretical entry point for most OR methods the Phase 3 of the standard ODMP. The ORSA personnel are actively involved in the whole ODMP and increase the effectiveness of this process by ensuring analytical rigor and continuity throughout mission planning, execution, and assessment though.

The ORSA helps Commanders to derive maximal benefit from its skills. With more ORSA positions among NATO countries and complex interoperability issues the Czech Armed Forces need to consider the implementation of such staff into its structures.

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