DECISION SUPPORT SYSTEMS IN MILITARY ACTIONS: NECESSITY, POSSIBILITIES AND CONSTRAINTS

Elena SUSNEA

"Carol I" National Defense University, Bucharest, Romania

Nowadays, modern organizations cannot resort to the decision-making process without relying on information and communication technology if they want to be successful. Thus, besides information as an important input of this process, the tools and techniques used by decision-makers are equally important in the support and validation of their decisions. All this is also valid for the military organizations and their specific tasks and activities. A fortiori military commanders face some of the most difficult and high-stake decision issues meaningful not only at the level of the military, but also for the humankind. Under these circumstances and as a result of an increase in the diversity and complexity of conflict situations, in the information and technology means employed by opponents in warfare and in the amount of information needed to be processed in real time, decision support systems become a necessity. Starting from the aforementioned inevitable requirement, the aim of this article is to emphasize the possibilities and constraints in developing an intelligent decision support system that assists commanders in making scientific decisions on time, under the right circumstances, for the right costs.

Key words: *DSS, military actions, management information systems*

1. INTRODUCTION

The subject of military theory is military action. The latter is defined as *"the result of human civilization, of armed confrontation between the formal and informal groups of society, their emergence and (counter)actions as a result of their mutual interdependence"* [1]

The planning and implementation of military action are part of the military decision-maker's competence. Consequently, the latter needs to decide on elements like procedure adoption to ensure military actions' leadership, establishment of force structures, structuring of operational orders, fire support, cooperation, command and control, military action support and forces protection.

Besides all of the above, technological innovation increasingly and decisively influences military actions. The new generations of intelligent weapons will be widely used in operations and military conflicts. Advanced information and

communication technology used in developing these weapons provide new military opportunities. This technology facilitates data gathering, processing and analysis, as well as information extraction and rapid dissemination to almost any conflict area. Moreover, the development of the military processes is under the direct influence of technological development. Therefore, it is not redundant to identify a clear direction towards using the new information and communication technology in the military field [2].

The development of Information Systems Management (ISM) contributed dramatically to providing the right means to gather and process the data needed by military leaders to extract meaningful information so as to increase the quality of all aspects related to the management of forces and material resources (information included). However, these systems have not enabled the generation of decision alternatives and appropriate solutions to address the new opportunities and issues related to military action. Therefore, they did not have the capability to solve some management problems. This shortcoming was solved through the development of Decision Support System (DSS).

The aim of this paper is to overview DSS and its relationship with the military field by identifying the major issues and opportunities provided by these systems in military actions.

2. DECISION SUPPORT SYSTEMS: BASIC CONCEPTS

Decisions are the outcome of managers' and leaders' work. In a globalized and increasingly complex and dynamic society, decision-makers should have the necessary abilities to decide better and quicker.

Beginning in the late 1970s, many practitioners and researchers focused on the development of computer-based systems that help managers make decisions based on scientific approaches. This initiative *"generated much optimism about the prospects for improving decision making"* [3].

In this respect, some authors consider that *"by the 1990s, the decision makers were well versed in mathematical and statistical techniques needed for usefulness analysis, operations research, decision matrices and probabilistic decision trees"* [4].

The term of decision support system (DSS) has many connotations but it can be mainly characterized as a *"model-based set of procedures for processing data and judgments to assist decision-makers"* [5] situated at different levels in the chain of command to solve semi-structured and unstructured decision tasks. Further, DSS stimulates the decision-makers to improve the decisional process and make the right decision in order to obtain high and quick performance. It also helps decision makers to extend their capabilities,

but it does not replace their decisions [6].

DSS are also seen as "*technologies that help convey the right knowledge to the right decision makers at the right time in the right representation, and for the right costs*" [7].

The APICS Dictionary defines DSS as "a computer system designed to assist managers in selecting and evaluating courses of action by providing a logical, usually quantitative analysis of the relevant factors" [8]. Therefore, this system can support military commanders in their primary job of making good, timely decisions. Routine, or structured, reports often do not help because they may contain data that may come in a too great amount, in the wrong form, or not timely enough. A DSS is designed to provide relevant information in a timely manner and a format that is easy to understand.

Thus, structurally, a DSS has four basic components: the data management subsystem, the management subsystem model, user interface, and users. There are some advanced DSS also containing the knowledge management subsystem [9]. The first three components are viewed as software parts, while the last try to include the decision maker. The multi-layered architecture provides powerful instruments for recognizing and solving problems during the decision making process [10]. As a result, military commander performs specific decision task based on a permanent dialogue with the system.

The support of the military commander and his staff in the decision-making process has to be the main objective of the respective systems in order to increase the overall efficiency of the Command and control – Reconnaissance – Effects integrated system. From this perspective, DSS contributes to the Command and Control Superiority [11].

3. MILITARY ACTIONS

3.1. Preliminary aspects

In its classical form, military action is defined as the total number of land, air and maritime operations led by a group of forces, elements and/or means belonging to various force categories within an environment characteristic for each of them, into a given geographical area, for given period of time, in a unitary manner, under the single command of an operational commandment in order to achieve some goals.

Regarding the nature of the participant forces, the types of operations executed are: joint, multinational, interdepartmental, and independent.

Under the current circumstances that are best characterized under the umbrella phrase of the twenty-first-century globalized world, the military action acquires new characteristics. Consequently, nowadays it resembles police actions and must be concerned with minimizing casualties for all sides, even at the risk of generating casualties among one's own forces.

Moreover, to be legitimate, such action must comply with international law provisions.

The military action tends to be the most visible and hazardous expression of national policy [12] and it must be the ultimate resort of political leaders. However, nowadays, even if the relation between the political decision and its military enforcement has not changed, things are not the same in the decision elaboration system. In this respect, it is worth reminding the increasing roles of international alliances and coalitions, of various security bodies, and of the media and public opinion. As a result, "political will" acquires new meanings and, regardless of the organization (i.e. great powers, NATO, the European Union, security organizations and coalitions) it is mostly oriented towards crises and conflict management, war prevention and the eradication of terrorism as a contemporary phenomenon. Consequently, the dynamics of military action is characterized by responsibility and global coverage.

3.2. DSS: some major issues

In our opinion, the introduction of a new DSS in the military action may lead to some important problems.

The first major problem consists of money and time constraints. In this respect, the acquisition and training costs required by an optimal use of the new DSS may prove impossible.

Second, the expansion of conflict areas involves a greater need to share data. In this context, there are concerns regarding the security of DSS knowledge and large databases. Moreover, the changes introduced by the new DSS may not be acceptable in terms of military doctrine or rules of engagement [13].

Third, the expertise developed by the decision-maker with previous systems may prove irrelevant in the context of the new procedures introduced by the new DSS. In this particular situation, the introduction of the new DSS may place all decision-makers at novice level.

While a computer system is the backbone of the DSS, it requires cross-functional teams to build the database and a model that is unique to the decision areas supported. From this point of view, the human factor plays an important role because the efficiency principle is related to how well the original data are organized in the system. It is also important the nature of data to be used as input for the system. Therefore, the objective and subjective quality of data is another issue that needs attention in the use of a DSS for taking decisions. This is because the poor data quality can lead to less effective decisional acts and poor decision outcomes.

The objective nature of data quality is based on evaluating the conformity of data to the initial specifications and integrity rules, or their correspondence to external phenomena. In this respect, measures related to data delivery, actual data use, and data users' perceptions must be taken. Furthermore, even with the

data that meet the basic requirements there may be some problems. Thus, data objectively evaluated as qualitative may be regarded as unsatisfactory by the managers who have to use them because of quality loss as a result of deficiencies in delivery mechanisms, processes or interfaces.

The subjectivity in data quality consists in the need for continuous feedback from the decision-makers on the problems encountered in data reception and processing.

A major issue in implementing DSS refers to the reduction of human errors. These computerized systems are intended to improve the performance of human operators by filtering and integrating raw process data, interpreting the status of particular situations, prioritizing goals and providing advice. Human operators focus their attention on the most relevant data and highest priority problems, and dynamically manage change situations more easily using the computerized system. There are many support systems used by DSS operators to aid the surveillance, diagnosis, and prevention of human errors. On one hand, there are indirect support systems using integrated graphic displays, configurable displays, ecological interface designs and information systems (e.g. the alarm systems). On the other hand, the direct support systems include intelligent advisors, computer-based procedures, fault diagnosis systems, and computerized DSS.

In our opinion, the development of Decision Support System (DSS) is challenging, as it must include system designers and specialists to ensure the cognitive fit between the DSS and the decision-maker so that decision-making effectiveness is maximized. The validation step from the DSS development process is very important because it determines how the implemented system satisfies the purpose and expectations of the user. Reducing human errors requires personnel trained in IT, but also military specialists.

A DSS that has already been used before is considered advantageous and necessary in order to shorten reaction time in the decision making process so that the results are included in relevant course of actions.

3.3. Possibilities

Military actions are complex situations occurring in complex environments. Therefore, the decisions taken in this field must be treated in a complex manner. The challenge is the integration of logical processes with military decision-makers' intuition in the obtaining of the most efficient decision alternatives. Concerning these alternatives, we agree with some authors who consider that *"by a complex situation, we mean one that may be difficult to define and may significantly change in response to some solutions; may not have a single "right" answer; is triggered by many forces; has no (or few) predecessors…"* [14].

In the complex environments characteristic of military actions where human errors may have tragic consequences, DSS are essential to the execution of complex tasks. The technological evolution constantly increases the scope of the operational theatre and the tempo of the response. Moreover, a huge load of uncertain data is generated by the environment. Clearly, this large amount of data may exceed the human capability in processing them. Information technology support is designed to cope with those human limitations in such complex environments. Thereby, intelligence decision making systems use data fusion that consists of processes automation so that diverse sets of raw data from different sources are combined into a single set of meaningful information that is greater than the sum of its contributing parts [15]. Due to this technology, the interval between data gathering to model creating is greatly reduced.

Decision Support Systems are often used as online alternatives to the development and analysis of courses of action (ACOA) and as tools that can be used for Online Doctrine and Tactics Techniques, and Procedures (DTTP) for support to operations. In this regard DSS offers the following possibilities:

- makes the evaluation of command and control processes and the friendly or foe capabilities' performance assessment possible;
- supports the military commander and his staff in their headquarters by increasing their ability to identify new opportunities;
- supports al phases of the command and control process;
- uses computer-based, automatic and closed models that can be adapted to the current situation [16].

As for the generic operations performed by DSS the following types can be used for military actions: file drawer systems, information models for analysis, representational models and suggestion models.

A pertinent example of a file drawer system is the one used by the US Department of Army called ARIMS (The Army Record Information Management System) that is applied to all unclassified Army records, including For Official Use Only (FOUO), regardless of medium, as well as to all Army records classified as SECRET (US Army Department: 2007).

The information models for analysis took many forms in the military field. One development has been an increased emphasis on building "realistic" models and simulations, including the so-called virtual world. These are more than mere analytic constructs designed to capture just enough about a system to do system analysis. They are attempts to study, understand, and interact with the real world through models that have increasingly high fidelity in many respects. A challenge at the frontier of the decision-making science is developing well-conceived families of models and human games

that are much more rigorous and mutually informed and that have been regarded as families of models in the past. A second development has been to discover new methods to help in the creative and imaginative aspects of strategic planning. Three such methods are Uncertainty-Sensitive Planning (USP), Assumption-Based Planning (ABP) and "Day After ..." games [17].

DSS is also used in situation assessment which is the ongoing process of inferring relevant information about the forces of concern in a military situation. Relevant information can include force types, firepower, location, and the past, present and future course of action. Situation assessment involves the incorporation of uncertain evidence from diverse sources. These include photographs, radar scans, and other forms of image intelligence, or IMINT; electronics intelligence, or ELINT, derived from characteristics of emissions generated by enemy equipment; communications intelligence, or COMINT, derived from the characteristics of messages sent by the enemy; and reports from human informants (HUMINT). These sources must be combined to form a model of the situation [18].

Among the DSS used in military action, the simulation systems used as adds-on to the C4I systems play an exquisite role especially in: all processes of command, control, communication, intelligence, reconnaissance, attrition, movement, etc. relevant to the problem to be solved which must be adequately modelled; the command agents and computer generated forces (CGF) that have to be used for automatic order generation and intelligent behaviour of simulated entities; the initial state of the simulation which must be generated automatically out of the data available from the C4I systems and adequate and validated data which must be available for the simulation system [16].

The DSS suggestion model has the role to produce suggestions about how to decide in certain situations. It is a model that can only support the repetitive decision situations and it needs an appropriate set of models in order to work.

Military actions depend on real-time information sharing to make time critical decisions. Inherent in this process are network-centric operations (NCO) that integrate the isolated air, land, sea, and space-based systems that gather, process, and disseminate vital information. NCOs enhance information sharing and collaboration to improve the quality of information and shared situational awareness.

3.4. Barriers to DSS implementation

Some of the main characteristics of today's security environment are *"exquisite technique and technological development in the military field and the easiness to access the products prone to be used as weapons by not necessarily*

well-intended categories of states and organizations" [19]. DSS is as effective as the context in which it functions and the individuals who use it. Here we speak about the existence of the qualitative and quantitative resources needed to implement a DSS, as a matter of suitable and standardized communication and information systems, trained personnel and decision-makers capable to analyze and interconnect computerized results with human intuition.

Issues regarding computer literacy and hardware/software requirements are identified as initial barriers.

The ability to integrate and correlate a vast amount of disparate information from multiple sensor and heterogeneous data resources of varying degrees of uncertainty in real-time is an impediment for mission-critical decision support systems (DSS).

One recognized characteristic for the successful implementation of DSS tools is their adaptability to the existent management approaches. In this respect, efforts for changing current/common management practices are necessary.

There are a series of factors contributing to the success or failure of DSS implementation. In terms of personal factors, there are many barriers in implementing DSS related to prior expectations, education, value and belief, impact on user's job [20]. The technical factors refer to user interface and system performance and reliability. There are also factors emerging from the interconnection of both personal and technical aspects in the form of social content gain and loss before and after DSS implementation. There are also other factors [23] related to the external environment, or some organizational aspects such as changes in the interpersonal relations and in the management processes that the DSS is designed to aid.

4. CONCLUSIONS

Over the past decade many researches and practitioners have broadened their activity focusing increasingly on the development of decision support systems that emulate human decision-maker capabilities. For the military field, the development of such systems is very useful in the current dynamic security environment.

DSS is a computerized system that is intended to interact with, and complement human decisions. Therefore, the ideal DSS for military actions must have the following characteristics: it provides the information needed by the commander; it can be easily controlled by humans dealing with large amount of data; it complements the power of the human mind by offering solutions to a wide variety of military problems.

The effectiveness of DSS depends on the resources needed to create it and on its appropriate design and use. The main issue when it comes to employing DSS in military action

is to confer superiority. This is all the more a stringent problem if the increase in battlefield information rate brought about by modern weapons, sensors, and tactics is taken into account. That requires selective but extensive application of automation to assist commanders and their staffs in reaching timely and appropriate decisions.

In our opinion, the problem of real-time decision-making represents a fundamental challenge to the artificial intelligence used in the military action, and has been kept under scrutiny by researchers.

REFERENCES

[1] Medzmariashvili Elguja (2011) Novel Approach to Indirect Actions in Military Theory, München: GRIN Verlag GmbH, p. 2..

[2] Şuşnea Elena, "Using Artificial Neural Networks in eLearning Systems", Scientific Bulletin, Series C, 72, 4, 2010.p. 92.

[3]Power J. Daniel (2002) Decision Support Systems: Concepts and Resources for Managers, Westport: Greenwood Publishing Group, Inc., p. 1.

[4] Sashkin Marshall (2001) Tough Choices: The Managerial Decision-Making Assessment Inventory, Seabrook: Ducochon Press, p. 17.

[5] Little D. C. John, "Models and Managers: The Concept of a Decision Calculus", Management Science, 16(8), 1970, http://mansci.journal.informs.org

[6] Filip G. Florin, Sisteme suport pentru decizii, Bucureşti: Editura Tehnică, 2004, p.59.

[7] Burstein Frada, Holsapple W. Clyde (editors), (2008) Handbook on Decision Support Systems 1, Berlin: Springer-Verlag., p. 21.

[8] Schuster W. Edmund, Allen J. Stuart, and Brook L. David (2007) Global RFID: The Value of the EPCGlobal Network for Supply Chain Management, Berlin: Springer-Verlag, p. 292.

[9] Turban Efraim, Aronson E. Jay, Liang Ting-Peng (2005) Decision Support Systems and Intelligent Systems, 7th edn., New Jersey: Pearson/ Prentice Hall, p. 292.

[10] idem, p. 663.

[11] Tolk Andreas, "Decision Support Systems – Technical Prerequisites and Military Requirements", in 2000 Command and Control Research and Technology Symposium Proceeding, June 2000, http://arxiv.org.

[12] Department of Defence of the United States of America, "Capstone Concept for Joint Operation, Version 3.0", http://www.dtic.mil/futurejointwarfare , (accessed September 1, 2012).

[13] Burstein Frada, Holsapple W. Clyde (editors), (2008) Handbook on Decision Support Systems 1, Berlin: Springer-Verlag. p. 4.

[14] Chen Miao, Zhu Qiuming, and Chen Zhengxin, "An Integrated Interactive Environment for Knowledge Discovery from Heterogeneous Data Resources", Journal of Information & Software Technology, 43, 1, July 2001.

[15] Petrov V. Plamen, Zhu Qiuming, Hicks D. Jeffrey, and Stoyen D. Alexander, "A Hierarchical Collective Agents Network for Real-time Sensor Fusion and Decision Support", in AAAI Workshop Technical Report WS-02-15, Menlo Park: AAAI Press, 2002.

[16] Tolk Andreas, "Decision Support Systems – Technical Prerequisites and Military Requirements", in 2000 Command and Control Research and Technology Symposium Proceeding, June 2000, http://arxiv.org.

[17] Davis K. Paul, Kulick Jonathan, and Egner Michael, Implications of Modern Decision Science for Military Decision-Support Systems, Santa Monica: RAND Corporation, 2005.

[18] Laskey Blackmond Kathryn, D'Ambrosio Bruce, Levitt Tod S., and Mahoney Suzanne, "Limited Rationality in Action: Decision Support for Military Situation Assessment", in Minds and Machines, 10, 1, February 2000.

[19] Atanasiu Mirela, "Reconfigurări şi redimensionări militare şi civil-militare ale luptei armate în războiul viitorului", in Securitate şi Apărare în Uniunea Europeană, Bucureşti: Universitatea Națională de Apărare „Carol I", 2008, p. 569.

[20] Vanrolleghem A. Peter, Decision Support for Water Framework Directive Implementation, London: IWA Publishing, 2011, p. 134).

[21] Cezar Vasilescu- Effective Strategic Making, Journal of Defense Resources Management, vol.2, issue 1, 2011, p.104.

[22] US Army Department, "The Army Records Information Management System (ARIMS), Washington DC, 2 October 2007", www.apd.army.mil (accessed September 1, 2012).

[23] Turban Efraim, Leidner Dorothy, McLean Ephraim, and Wetherbe James, Information Technology for Management: Transforming Organizations in the Digital Economy, New York: John Wiley & Sons, Inc., 2007.