THE PERSPECTIVE OF DECISIONAL ARCHITECTURES FOR MILITARY OPERATIONS PLANNING AND CRITICAL INFRASTRUCTURE PROTECTION

Colonel Assoc. Prof. Daniel ROMAN, PhD

"Carol I" National Defence University

DOI: 10.55535/RMT.2026.1-2.01

The complexity of the current operational environment, shaped by the ongoing Russia-Ukraine war near Romania, requires new strategies for crisis anticipation and risk management with major societal impact. Military operations planning and critical infrastructure protection are key elements for ensuring national security and societal stability.

In this uncertain and interconnected context, "decision architecture" emerges as an essential predictive tool. This approach to decision-making integrates actors, information flows, and support tools, while technologies such as artificial intelligence and advanced data analysis enable the development of adaptive systems designed to anticipate and prevent negative outcomes. The coordinated efforts of civil and military authorities enhance prevention, enable rapid response, and ensure the continuity of vital societal functions.

The article proposes a decision-making system based on three pillars: improving risk anticipation by identifying vulnerabilities, optimising decision options through adaptive mechanisms, and creating a multi-actor framework for predictive analysis, all contributing to strategic resilience and integrated security.

Keywords: military operations; critical infrastructures; vulnerability cluster; artificial intelligence; sensemaking;

INTRODUCTION

The issue of emerging crisis situations or the potential materialization of adverse events with major societal impact has been, is, and will remain one of the major concerns of security and defence specialists. If the answer to the question: *"Can a crisis situation or the materialization of a negative event with major societal impact be anticipated?"* is affirmative, we will investigate the mechanisms that result in such an answer. In operational art, the *planning of military operations* develops specific dimensions of knowledge about the current operational environment, while situation analyses allow investigation of a potential enemy's behaviour – an approach through which courses of action can be constructed and, based on identified criteria, transformed into concepts of operations, plans, and subsequent orders. In other words, possible future situations are identified to pursue advantages, much like a roadmap describing the path to achieving victory.

In operational art, the planning of military operations develops specific dimensions of knowledge about the current operational environment, while situation analyses allow investigation of a potential enemy's behaviour – an approach through which courses of action can be constructed and, based on identified criteria, transformed into concepts of operations, plans, and subsequent orders.

A similar approach to analysing and anticipating the future is found in the societal domain of *critical infrastructure protection*, where threats and vulnerabilities to an entity or critical infrastructure are monitored – factors that can transform a state of normality into a crisis or into the materialization of an adverse event with major societal impact: loss of human life, considerable material damage, or large-scale economic and social effects. In the same context, the unprecedented pace of technological development – especially the operationalization of decision-assistance platforms using artificial intelligence – calls for a new approach to the future and particularly to risks. In this way, risks – or rather risk management – shift their operational attributions from prevention alone to prediction and prevention, as mechanisms for generating solutions to warn of and counter potential crisis situations.

RESEARCH METHOD

Given the complexity of the chosen subject, multiple methods are employed to support the attainment of concrete results that can be validated in opening new perspectives on the *typology of decisional architectures*. In this context, a combined method is used that brings together features of comparative analysis, systemic analysis, and the method of scenarios, in relation to an applied case study. In anticipating the content and final outcome of this article, two guiding questions are posed: *"What is the new conceptual framework of decisional architectures?"* and *"How might these architectures function in a current crisis situation?".* Through the comparative method, defining features are identified for a crisis situation – the *Great Famine* in Ireland (1845–1852) – and for current critical infrastructures; through systemic analysis, an examination is conducted of how some decisional networks of critical infrastructures and those specific to the military domain are built, as interdependent systems that seek to identify vital functions, critical nodes, and cascading effects. The *scenario method* aims to construct courses of action by situating events in space and time and by mapping effects and consequences – results that drive a shift from a current situation toward a crisis or toward favourable conditions for a given context. The article concludes with a series of findings and proposals regarding the efficiency of anticipating and managing crisis situations through the lens of integrated decisional architectures. It is argued that decision ecosystems correlate the systemic analysis of vital societal functions with critical interdependencies, in a context where crises do not occur in isolation but as interconnected phenomena with the potential to propagate in cascade across the societal whole.

The scenario method aims to construct courses of action by situating events in space and time and by mapping effects and consequences – results that drive a shift from a current situation toward a crisis or toward favourable conditions for a given context.

FROM THE CENTRE OF GRAVITY OF OPERATIONAL ART TO VULNERABILITY CLUSTERS WITHIN DECISION ECOSYSTEMS

The frequent use of the phrase *"modern society"* is justified by the fact that, at certain intervals, specific societal transformations occur that confer this characteristic upon a given historical period. Yet situations evolve, and not always toward the positive, depending on the angle from which analysis is conducted and on the way events similar to those of the past are referenced. In any case, situation

analysis is about *knowledge* – about how events unfold, what causes and, more precisely, what influencing factors are at play, how they interact, and what effects and consequences they generate.

To identify relevant aspects regarding the concepts of *decision ecosystems*, *critical infrastructures, and societal resilience*, this article references a complex historical event that unfolded for over seven years and claimed many victims – the *Great Irish Famine* of 1845–1852 (Mokyr, Ó Gráda, 2002, pp. 339-363). In brief, in 1840s Ireland, the potato had become the staple food for more than a third of the population; excessive dependence on a single crop, without redundancy or dietary alternatives, constituted a structural vulnerability. From a systemic perspective, the potato represented a vital function without which the rural poor could not survive. The infestation of the potato by the pathogen *Phytophthora infestans* and the lack of dietary diversification transformed an agricultural hazard into a national catastrophe. Classified as an adverse event with major societal impact – given approximately one million deaths and over two million emigrants – the *Great Irish Famine* stands as a *societal collapse* with lasting effects on Ireland's demographic, cultural, and political structure, leading to the irreversible loss of public trust in authorities and generating cascading effects that fostered Irish nationalism and fuelled subsequent conflicts in the region.

Classified as an adverse event with major societal impact – given approximately one million deaths and over two million emigrants – the Great Irish Famine stands as a societal collapse with lasting effects on Ireland's demographic, cultural, and political structure, leading to the irreversible loss of public trust in authorities and generating cascading effects that fostered Irish nationalism and fuelled subsequent conflicts in the region.

The onset of the 1845 food crisis was generated by a series of decisions taken in isolation by the British government, local authorities, and landowners; in the absence of collaboration or societal feedback, those decisions led in subsequent years to what is termed *societal collapse*. Given the shortage of food resources and the failure to seize opportunities to halt or reduce food exports from Ireland, negative effects intensified, resources were not redistributed, defensive preparedness (stocks, dietary alternatives) was absent, and decision alternatives were not converted into societal advantage to counter the crisis.

Another important aspect concerns the cascading or network effect at the societal level: the famine affected not only food supply, but also health, migration, public trust, and political stability. Today, it corresponds to inter-institutional work – e.g., among different ministries and national and international organizational structures

(holders of national critical infrastructures/CI and international critical infrastructures/ICI).

Succinctly formulated, the first hypothesis advanced in the above context is: *"The efficiency of anticipating and managing crisis situations depends on the existence of integrated decisional architectures that connect the systemic analysis of vital societal functions and critical interdependencies with mechanisms of adaptive and collaborative resilience".* Thus, the need has been identified for decisional structures that operate on realistic ground data while also relying on courses of action whose plausible results define the foundation of systemic societal analysis. A first argument is that crisis situations never manifest in isolation; they are part of interdependent systems.

"The efficiency of anticipating and managing crisis situations depends on the existence of integrated decisional architectures that connect the systemic analysis of vital societal functions and critical interdependencies with mechanisms of adaptive and collaborative resilience".

On this basis, modern critical infrastructures (energy, food, health, cyber, transport etc.) function as nodes within a complex network (Roman, 2016, pp. 67-73). Isolated analysis of a single component (such as the Irish food crisis) cannot explain cascading effects when a local vulnerability propagates at national or transnational level. Therefore, only an integrated decisional architecture that considers vital societal functions and the links among them can provide a solid basis for anticipation and effective response. As Barabási (2016/2021) shows, complex systems operate based on critical nodes and scale-free distributions, meaning local shocks can transform into systemic disruptions through network effects. In the context of critical infrastructure protection, this type of analysis is indispensable for identifying vulnerability clusters and the decision points required by operational design during the planning phase (Barabasi, 2002, pp. 14-20).

Vulnerability clusters are groups of nodes and interconnections within a societal network (military, economic, transport, health etc.) where a local vulnerability has the potential to generate disproportionate cascading effects at the level of the entire societal system. In other words, vulnerability clusters are those *"weak zones"* of the network where shocks propagate rapidly and can destabilize the societal system even if the starting point is small. The *Great Irish Famine* of 1845 was triggered by a single agricultural deficiency – the infestation of the potato by *Phytophthora infestans* – and, in the absence of a societal security plan, the mentioned cause unleashed the cascading propagation of effects and consequences discussed

above, summarized as: *potato dependence + lack of logistics infrastructure + trade policies = vulnerability cluster.*

Approaching societal reality as a network of nodes and links opens new analytical perspectives, both for military operations planning and for critical infrastructure protection. These perspectives are generated by a conceptual shift from *"identifying the centre of gravity"* to *"identifying vulnerability clusters".* The main arguments for this replacement centre on the defining characteristics of vulnerability clusters:

- high connection density – nodes are interconnected with varying intensities, enabling the transmission of a societal shock either slowly or rapidly, depending on the nature of the links among societal nodes;
- existence of critical dependencies – nodes depend on the same resource, supplier, or infrastructure, leading to crisis through direct impact on sources of supply;
- lack of redundancy – alternatives are few or non-existent; thus, failure of a key node blocks the entire cluster, raising the issue of sustainability based on interoperability;
- operational proximity – in which entities in the cluster are linked through common processes or functions (e.g., energy + transport + hospitals).

Bridging concepts of threats and vulnerabilities by shifting situation analysis from identifying the centre of gravity to describing the vulnerability cluster is justified by the connective thread of past events (e.g. the *1845–1852 Irish Famine*), ongoing events (the war in Ukraine), and the prediction of future events that may occur through the extension of an ongoing crisis or the onset of new crises. It is evident, due to the relevance of vulnerability clusters for decisional architectures, as follows:

Bridging concepts of threats and vulnerabilities by shifting situation analysis from identifying the centre of gravity to describing the vulnerability cluster is justified by the connective thread of past events (e.g. the 1845–1852 Irish Famine), ongoing events (the war in Ukraine), and the prediction of future events that may occur through the extension of an ongoing crisis or the onset of new crises.

- identifying vulnerability clusters is the first step in designing Operator Security Plans (OSP) – a requirement also present in operational design during the military operations planning stage;
- shifting the paradigm away from seeking a single centre of gravity, cluster analysis shows where redundancies and protective capabilities must be placed for critical entities and infrastructures;

- decision ecosystems are the only entities able to integrate such multi-criteria analyses (on influencing factors) to prioritize resources and increase the resilience of the societal system as a whole;
- correlating risks within a systemic methodology by identifying zones of vulnerability across the entire system (instead of a linear approach in which each risk is treated in isolation, decision ecosystems enable visualization of the *risk network* – how a threat can propagate simultaneously across multiple societal domains).

The combined integration of risks and vulnerability clusters into the concept of decisional architectures – for example, in the processes of military operations planning and critical infrastructure protection – ensures the transition from security based on reaction to resilience based on anticipation and adaptation.

The combined integration of risks and vulnerability clusters into the concept of *decisional architectures* – for example, in the processes of military operations planning and critical infrastructure protection – ensures the transition from security based on reaction to *resilience based on anticipation and adaptation*. In this context, new concepts can be developed regarding decision ecosystems that support decision-making not only by identifying risks, but also by simulating scenarios, comparing courses of action, and validating optimal options for responding to crisis situations or to the materialization of adverse events with major societal impact. In this way, critical infrastructure protection and military operations planning converge within a common framework of critical thinking capable of transforming uncertainty into operational opportunities.

A PARADIGM SHIFT IN DECISION-MAKING FOR MILITARY OPERATIONS PLANNING AND CRITICAL INFRASTRUCTURE PROTECTION

The theoretical confirmation of the hypothesis formulated in the first part of the article opens new perspectives for military operations planning and for developing mechanisms to protect critical infrastructures by shifting the paradigm *from linear to systemic thinking*. For many years, both military planning and critical infrastructure protection relied on *linear causal logic* by identifying the centre of gravity and applying the convergence of decisive actions to achieve victory or ensure functional continuity. However, the current reality – characterized by interdependencies and network effects – renders these models insufficient. The new paradigm is grounded in *systemic*

critical thinking, wherein emphasis shifts from a single vulnerable point to the concept of vulnerability clusters and the interactions among societal domains.

Decision-making has become increasingly complex due to the sheer volume of information, generating difficulties in solving decisional problems. The specialized literature indicates four main stages of the decision process: *investigation and problem definition; the design of potential solutions; the choice of the best option* in line with established objectives and criteria; and *the evaluation of effects along with decision implementation.*

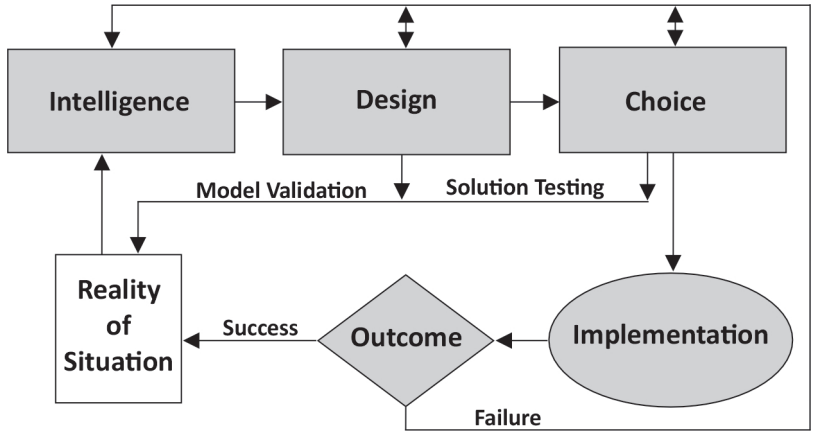

Figure 1: Logical support schema of the system for decision development (Marakas, 2003)

The specialized literature indicates four main stages of the decision process: investigation and problem definition; the design of potential solutions; the choice of the best option in line with established objectives and criteria; and the evaluation of effects along with decision implementation.

To support decision-makers in taking rapid, high-quality decisions, Decision Support Systems (DSS) are employed (Sprague, Carlson, 1982). These are interactive information systems that integrate concepts and applications from diverse fields such as economics, medicine, military operations, computer science, and artificial intelligence. A decision-assistance system must be flexible, offer *multiple options for analysis,* develop *diverse styles and classifications*, and allow the *evaluation of alternatives together with their consequences*. DSS can be successfully used in industrial environments (e.g., production management, resource allocation, systems planning, process supervision and control) as well as in any other domain that involves problem-solving under risk. In the military domain, solving problems under risk and uncertainty is accomplished through the mechanisms of operational art – the intermediate level between strategy and tactics.

Operational art is itself *"a mechanism for solving unstructured problems"*, referring to how resources and forces are arranged, coordinated, and integrated in space and time to achieve operational and strategic objectives. In synthesis, military operations planning entails successive – but also simultaneous – steps: systemic analysis of the operational environment, identification of centres of gravity, synchronization of forces and resources, and integration across domains (land, air, maritime, cyber, and space) (Bolia, Smith, 2006, art. 13). Following the logic of operational art in the military context as well as that of systemic thinking, *clusters* can be seen as agglomerations of capabilities, units, and interconnected resources designed to create synergy and superiority effects in confrontation with a potential adversary.

Operational art is itself "a mechanism for solving unstructured problems", referring to how resources and forces are arranged, coordinated, and integrated in space and time to achieve operational and strategic objectives.

From the standpoint of operational art and systemic critical thinking, both centres of gravity (CoG) and vulnerability clusters are conceptual instruments for solving unstructured problems – *situations in which a single clear solution does not exist and multiple courses of action are possible* (Nguyen, Armarego, Swatman, 2002).

With respect to such problems, we note high uncertainty about the dynamics of the operational environment, the adversary, and its intentions, as well as about the nature of the formulated objectives, which may be conflicting or insufficiently clear; numerous interdependent variables (political, economic, social, military) are at play. Given this context, military operations planning cannot rely solely on algorithms and procedures; conceptual approaches are needed to provide flexibility for decomposing unstructured problems into structured ones.

In the military decision process, situation awareness and the design of courses of action enable the formulation of a concept of operations. Logically, the process has two components: one referring to situation awareness for anticipatory projection – describing the operational environment and the adversary's behaviour – *Sensemaking*; and a second component in which the actual planning process constructs courses of action – *Planning* – followed by the concept of operations and operations orders to achieve the formulated end-state.

If the anticipated results in the form of alternative scenarios or prospective courses of action (which explore the likely impact of each action on the estimated cascading effects) are unacceptable, actors will attempt to reconfigure them toward more favourable end-states

(Albino at al., 2016). This presupposes understanding the actions and the direct/indirect effects that can generate those objectives that drive the operation toward the desired final state. In this context, analysing vulnerability clusters – unlike identifying centres of gravity – means focusing on interconnected agglomerations of weaknesses across logistics, information, political, social etc. aspects, whose coordinated exploitation can accelerate attainment of the desired end-state. (Cîrciumaru, 2023). Thus, *"what if" projections* must include not only courses of action oriented toward neutralizing centres of gravity, but also options designed to test how exploiting vulnerability clusters can generate cumulative and disproportionate effects upon the adversary's entire system.

Analysing vulnerability clusters – unlike identifying centres of gravity – means focusing on interconnected agglomerations of weaknesses across logistics, information, political, social etc. aspects, whose coordinated exploitation can accelerate attainment of the desired end-state.

Because operations unfold within a multi-level, complex, and adaptive system, end-states never manifest at a single level or within a single domain. They produce cross-domain impact – political, military, economic, social, informational, and infrastructural – and influence behaviours in subsequent cycles of interaction (Cucinschi, Chiorcea, 2022, pp. 29-39). From this perspective, *identifying vulnerability clusters* becomes a critical component of planning, enabling the generation of flexible, feasible, and synchronized options capable of shaping the operational environment in the desired direction.

By integrating the *Sensemaking* module, one obtains *"the process necessary to make sense of a situation"* through which a decision-maker/commander, a staff, or a decisional community transforms fragmentary, incomplete, and ambiguous data about the operational environment into a coherent and usable understanding for decision-making.

Building the workflow of social/societal, cognitive, and informational components enables the assessment of a societal situation and highlights the cognitive working module – *Sensemaking*. The role of this module is not merely to collect information, but above all to construct meaning in problem formulation, namely: *the interpretation, integration, and projection of the obtained data into scenarios and courses of action* according to the effects and consequences that may occur. In other words, sensemaking is the *"bridge"* between reconnaissance/intelligence and the design of courses of action – a way of providing the necessary support for anticipating the future. This aspect is important because it enables not only reaction to the materialization of an event, but also future

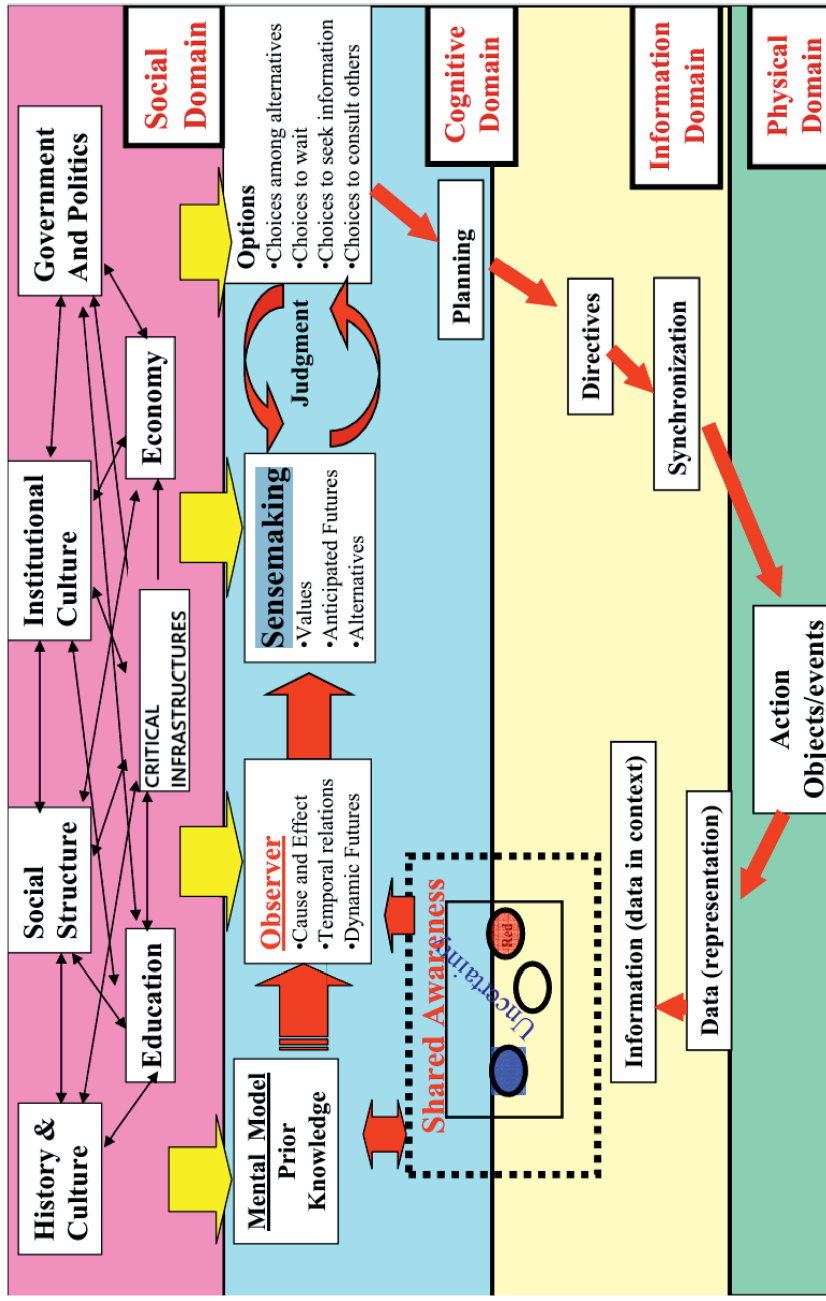

Figure 2: An example workflow diagram of social/societal, cognitive, and informational components in assessing an operational-environment situation (Smith, 2005, p. 4)

projection/prospection through the *"what if"* conditionality needed to test possible consequences for the desired end-state. In relation to the processes of CoG and vulnerability-cluster identification, this approach enables the integration of AI and emerging technologies, which – through data-analysis algorithms and predictive simulations – thus become extensions of the sensemaking process rather than mere technical tools.

In this context, starting from the *"what if – Sensemaking"* analysis point, three fundamental directions open for solving unstructured problems:

1. strengthening anticipation and risk-analysis capacity, grounded in identifying vulnerability clusters rather than a single centre of gravity;

2. optimizing the selection of decision options through adaptive mechanisms in relation to the complex of effects and consequences;

3. developing a multi-actor framework for predictive analysis that is sufficiently comprehensive to be meaningful.

By including the sensemaking cognitive module and *"what if"* scenarios, decisional architecture allows not only reaction to the materialization of risks, but also future prospection and testing of possible consequences for the desired end-state. The integration of artificial intelligence and emerging technologies transforms the decision process from a simple technical act into an extension of the organization's cognitive mechanism, wherein predictive analytics, simulations, and data algorithms provide support for continuous anticipation and adaptation. Through this approach, advanced decisional architectures emerge as indispensable solutions for achieving resilience and transforming the uncertainty of the operational environment into an opportunity to prevent a crisis situation.

The integration of artificial intelligence and emerging technologies transforms the decision process from a simple technical act into an extension of the organization's cognitive mechanism, wherein predictive analytics, simulations, and data algorithms provide support for continuous anticipation and adaptation.

IN LIEU OF A CONCLUSION

In developing this article, the starting hypothesis concerns the efficiency of anticipating and managing crisis situations in relation to the evolution of integrated decisional architectures that connect the systemic analysis of vital societal functions with critical interdependencies as mechanisms of adaptive and collaborative resilience. This hypothesis finds its foundation in the reality of the current operational environment, whereby crisis situations never manifest in isolation, but as part of interdependent systems in which

the vulnerability of one domain can rapidly turn into a disruption with cascading effects and consequences across the societal whole.

Accordingly, starting from the specifics of the 1845-1852 crisis in Ireland, this article highlights the need for decisional structures capable of operating on realistic field data as well as on prospective scenarios that test the possible consequences of courses of action – measures necessary given the dynamics and unpredictability of the current operational environment. Modern decisional architectures, supported by artificial intelligence, predictive simulations, and multi-actor mechanisms, can transform the decision process from a reactive act into an *anticipatory and adaptive mechanism.* By integrating elements of systemic analysis, shifting from identifying a centre of gravity to identifying and describing vulnerability clusters, and by addressing mechanisms of resilience and inter-institutional collaboration, the premises of an advanced decisional system – here assimilated to the concept of a *decision ecosystem* – take shape. On this basis, viable solutions can be designed to address most challenges generated by the complexity and uncertainty of today's operational environment.

The integration of artificial intelligence and emerging technologies transforms the decision process from a simple technical act into an extension of the organizational cognitive mechanism, wherein predictive analysis, simulations, and data algorithms provide support for continuous anticipation and adaptation.

Another observation concerns how problems specific to military operations planning and critical infrastructure protection – two essential reference points in contemporary decisional architecture – are solved. In an operational context characterized by uncertainty, interdependencies, and time constraints, the concept of the decision ecosystem emerges as an indispensable predictive instrument for managing complex situations. In both the military environment and that of critical infrastructures, the decision-making process entails integrating key elements – actors involved, information flows, and decision-support tools – that can be leveraged in developing new planning concepts.

By including the *sensemaking cognitive module* and *what if scenarios* within decisional architectures, new horizons open regarding how analysed entities react to the materialization of identified risks. In the same equation, new opportunities are leveraged to prospect the future and test possible consequences for the desired end-state. The integration of artificial intelligence and emerging technologies transforms the decision process from a simple technical act into an extension of the organizational cognitive mechanism, wherein predictive analysis, simulations, and data algorithms provide support for continuous anticipation and adaptation.

As a final conclusion, the perspective on decisional architectures for military operations planning and critical infrastructure protection changes substantially due to the possibility of solving unstructured problems by strengthening anticipation and risk-analysis capacity within decision ecosystems. It becomes possible through a paradigm shift – from identifying a centre of gravity to identifying and analysing vulnerability clusters – which enables the optimization of decision-option selection through new adaptive mechanisms of analysis, planning, and decision-making.

BIBLIOGRAPHY:

1. Albino, D.K., Friedman, K., Bar-Yam, Y., Glenney IV, W.G. (2016). *Military Strategy in a Complex World, Physics and Society* (physics. soc-ph) Report number: New England Complex Systems Institute Report.
2. Barabasi, A.-L. (2002). *LINKED – noua știință a rețelelor*. Timișoara: Editura Brumar, ISBN 978-606-726-088-5, pp. 14-20.
3. Bolia, R., Smith, R. (2006). *The Utility of Force: The Art of War in the Modern World*, in *Naval War College Review*, vol. 59, no. 2, art. 13.
4. Cîrciumaru, F. (coord.); Ioniță, C.-C., Zodian, M., Atanasiu, M., Sarcinschi A. et al. (2023). *Evaluare strategică 2023. Riscuri, incertitudine, război. Monografie*. București: Editura U.N.Ap. "Carol I".
5. Cucinschi, Al., Chiorcea, I. (2022). *Obținerea de efecte interdomenii – provocare impusă de operația multidomeniu*, in *Impact Strategic*, no. 3-4. București: Editura U.N.Ap. "Carol I", pp. 29-39.
6. Marakas, G.M. (2003). *Decision Support Systems in the 21st Century*. Philadelphia University Faculty of Information Technology Department of MIS, 2nd ed., Pearson Education.
7. Mokyr, J., Ó Gráda, C. (2002). *What do people die of during famines? The Great Irish Famine in comparative perspective*, in *European Review of Economic History*, 6(3), pp. 339-363.
8. Nguyen, L., Armarego, J., Swatman, P.A. (2002). *The Structure of Ill-Structured Problems*, https://www.researchgate.net/publication/2546878, retrieved on 22 September 2025.
9. Roman, D. (2016). *Critical Infrastructure Protection from a Systemic Perspective*, in *Strategic Impact*. București: Editura U.N.Ap. "Carol I, no. 59, pp. 67-73, https://scholar.google.com/citations?view_op=view_citation&hl=ro&user=4tKvGe8AAAAJ&citation_for_view=4tKvGe8AAAAJ:YOwf2qJgpHMC, retrieved on 10 September 2025.
10. Smith, Jr., E.A. (2005). *Complexity, Networking, and Effects-Based Operations: Approaching the "how to" of EBO*, The Boeing Company, Arlington, Virginia, p. 4.
11. Sprague, R.H., Jr., Carlson, E.D. (1982). *Building Effective Decision Support Systems*. Englewood Cliffs, NJ: Prentice-Hall.