



MILITARY MOBILITY – A PRESENT-DAY REQUIREMENT –

Colonel Daniel GHEONDEA, PhD Candidate

“Carol I” National Defence University, București

Professor BEng Toma PLEȘANU, PhD

“Nicolae Bălcescu” Land Forces Academy, Sibiu

DOI: 10.55535/RMT.2022.1.03

The current security threats identified in the vicinity of the European Union Member States generate new approaches in the field of collective defence, in close connection to the reanalysis of practical ways to implement mutual support and increase the military mobility of the allied countries, taking into account the multiple legislative and procedural implications, the need for well-founded analyses of the transit areas and the efficient use of the available transport infrastructure. Referring to the national approach, analysed from the perspective of the mobility-force protection binomial, the military mobility highlights the need to identify relevant solutions for approaching various obstacles, manoeuvring in the tactical field, ensuring the viability of roads and identifying routes to bypass inaccessible areas. Also, knowing the existing limitations in transport infrastructure and identifying the solutions to eliminate them are priorities for all the European states. In order to substantiate the decisions to increase military mobility, viewed from both a national and a multinational perspective, the military planners can use the mathematical models for the decision-making process under certainty conditions, which leads to viable well-founded solutions that can underlie the success of the military operations involving different structures of military forces.

Keywords: security; military mobility; European Union; NATO; mathematical models;



INTRODUCTION

The beginning of the 21st century, marked by numerous military conflicts and more or less extensive political crises in different geographical areas of the world, brings to the fore the need for most countries in the world to take new security measures to counterbalance the current threats. Making a direct reference to our country, Romania cannot stand aside in the field of security, especially since we are in a “hot” area, on the border between NATO and Russia, marked by numerous incidents in the Black Sea region and in the vicinity of the smouldering conflicts in Transnistria and Ukraine. At the same time, various European countries are living under constant security threats, referring here to Poland and the Baltic countries.

The problems of security uncertainty also lie in the recent events related to the incidents on the Polish border with Belarus or the scale of the *Zapad-2021* exercise (Rumer, 2021), which was attended by significant military forces from Russia and Belarus. Specifically, given that Belarus encourages and facilitates the passage of migrants towards Poland, we are witnessing the construction of a barbed wire fence along its 418-kilometer border with this country in order to reduce illegal migrant crossings. As the incidents on the Polish border are on the rise, we need to analyse these security issues from a European perspective and see what steps are required to take in order to maintain security on the old continent. We must not omit the fact that there are already armed forces belonging to several states, Romania included, in Poland, our country participating with a subunit of air and missile defence.

Secondly, the *Zapad-2021* exercise conducted at the NATO border is characterised as a real show of strength, with the estimated participation of about 200,000 soldiers, over 290 tanks, over 240 multiple launch rocket systems and mortars, about 80 fixed and rotary-wing aircraft and 15 warships, simulating a battle with none other than the North Atlantic Alliance forces. This kind of military manoeuvre always

The Zapad-2021 exercise conducted at the NATO border is characterised as a real show of strength, with the estimated participation of about 200,000 soldiers, over 290 tanks, over 240 multiple launch rocket systems and mortars, about 80 fixed and rotary-wing aircraft and 15 warships, simulating a battle with none other than the North Atlantic Alliance forces.



In the current context, in which Europe is going through a period of security uncertainty, NATO's partnerships with the European Union can ensure cooperation on common interest issues and help counter threats and challenges to the international security in general and the European security in particular.

raises suspicions, especially given that the recent history has shown that the 2008 invasion of Georgia was preceded by the *Caucasus Frontier* military manoeuvres carried out between 2006 and 2008, and in the case of the annexation of the Crimean Peninsula, the troop manoeuvres were also disguised under the pretext of similar military exercises. However, apart from its magnitude (the number of troops being far superior to *Zapad-2013* or *Zapad-2017* exercises), one of the strangest aspects of *Zapad-2021* is the stated purpose of the exercise: the Red Army is training for the event of a conventional, large-scale war with NATO.

In the current context, in which Europe is going through a period of security uncertainty, NATO's partnerships with the European Union can ensure cooperation on common interest issues and help counter threats and challenges to the international security in general and the European security in particular. The role of NATO and the agreements established at the level of the European Union become defining, and Romania cannot miss from this equation due to its membership of NATO and of the European Union. It is also necessary to admit the importance of the military exercises in which our country participates and especially the multinational ones carried out on the national territory, thus proving a firm reaction to the previously mentioned threats.

One of the real problems that the military planners of these exercises must solve is to ensure adequate mobility of the forces participating in the exercises, in the context in which they must be redeployed from certain regions, requiring crossing different countries, and must act as a unitary force in the areas established for the conduct of the exercises. Actual examples in this regard are the *Saber Guardian* (MND, 2020) or *Noble Jump* (NATO, 2021) exercises carried out in our country, which involved large-scale military manoeuvres of several NATO military structures, which transited several land, air or sea routes, so that the mentioned military exercises may proceed in the prescribed time frames, in the areas assigned to each formation, according to a well-established schedule.

In another vein, the increase in the security or terrorist threats require that the European states should reanalyse the practical ways

to ensure regional security in terms of collective defence. It is a reality the fact that we are witnessing a globalisation of security, seen as a counterweight to the unpredictable development of another current phenomenon located “on the other side of the barricade”, namely the globalisation of insecurity. In these circumstances, the European states have adopted new security priorities, in which regional security becomes paramount over their own security.

The idea of collective defence is not new, being the result of the missions identified in terms of the increase in threats and the vulnerability of different states. Therefore, article IV of the Brussels Treaty (2018) and Article 5 of the Washington Treaty (1949) expressly provide that the signatory States have an obligation to assist each other in the event of aggression in order to restore security. The implementation of mutual support involves the mobility of the military structures of the partner countries, with multiple legislative and procedural implications as well as the need to perform well-founded analyses of the transit areas and the efficient use of the transport infrastructure. All these are important issues on the European agendas, and the ultimate goals tend to a unitary outcome: ensuring European security.

MILITARY MOBILITY FROM A EUROPEAN AND NATO PERSPECTIVE

We consider mobility as an indispensable asset in the military field, which can make a difference on the modern battlefield that is continuously changing, with unprecedented technological developments. Also, in our approach to the military mobility and its importance, we consider it appropriate to highlight this aspect by referring directly to the mobility of the German armed forces in the two world wars, especially the mobility of the submarines in the First World War and the mobility of the land forces of the same country during the “Lightning War”, specific to the Second World War, with the examples of the land operations for the conquest of Poland or the crossing of the Ardennes.

Taking a leap in time, at the beginning of the 21st century, we note that the military mobility is a major area of interest for the modern



ROMANIAN
MILITARY
THINKING

The idea of collective defence is not new, being the result of the missions identified in terms of the increase in threats and the vulnerability of different states. Therefore, article IV of the Brussels Treaty and Article 5 of the Washington Treaty expressly provide that the signatory States have an obligation to assist each other in the event of aggression in order to restore security.



Better mobility of forces inside and outside the EU will increase European security to the point of allowing EU Member States to act more quickly, in line with their defence needs and responsibilities, both in the context of the joint security missions and the national and multinational defence policies.

armed forces, which try to approach new ways to improve this capability, in order to increase the manoeuvrability of all services, given the increasingly varied threats. NATO and the EU cannot avoid these threats and make sustained efforts to achieve and maintain adequate military mobility, so that military structures belonging to different Member States could redeploy in a short time to new assigned areas of operations, providing adequate protection to the forces during the execution of specific manoeuvres.

The year 2017 is an important milestone in the effort to create a common defence of the European Union, with the promulgation within the European Commission of a report outlining the importance and the need for future measures to this purpose, with a view to 2025. At the same time, this report sets out the steps needed to build a more united, more efficient and effective European Union capable of defending the common interests and priorities of its members in promoting peace and guaranteeing the security of its citizens and territory, as set out in the EU Strategy on foreign and security policy. In this respect, some relevant aspects of joint defence and possible ways of putting this project into practice, which could be feasible in all Member States, are also tackled. As a result, twenty-five EU Member States have decided to include military mobility among the commitments made in the Permanent Structured Cooperation Plan launched on 11 December 2017 (The Council of Europe, 2021). The Council of Europe of December 2017 promoted European military mobility both in the framework of the permanent structured cooperation and in the context of the EU-NATO cooperation. The new approach admits the idea that better mobility of forces inside and outside the EU will increase European security to the point of allowing EU Member States to act more quickly, in line with their defence needs and responsibilities, both in the context of the joint security missions and the national and multinational defence policies.

Within this project, an important role is given to improving military mobility in all EU Member States, a mobility that ensures, where necessary, the implementation of the common defence measures and the effective mutual support when the situation requires it. Thus, the facilitation of the movement of troops and military means is considered

to be essential for the security of the European citizens and a sine-qua-non condition for building an efficient more integrated European Union with a better capability to respond to security threats. This issue was identified in the report on improving military mobility in the EU in November 2017 and has become a desideratum of the EU's Global Strategy on Foreign and Security Policy. The action plan presented in this regard identifies a number of operational measures to remove the physical, procedural or regulatory barriers that impede military mobility. In our opinion, the close cooperation with the EU Member States and all the relevant actors is a priority for the implementation of this action plan.

The action plan on military mobility was developed within the European Defence Agency, suggesting practical actions in the following key areas: military requirements, transport infrastructure and regulatory and procedural issues.

The first area, of military requirements, is the starting point for a coordinated and effective approach to military mobility across the EU. The European External Action Service (EEAS) and the EU Military Staff are the structures designated to develop these military requirements, reflecting the needs of the EU and its Member States, including the infrastructure needed for military mobility. Identifying and reaching an agreement on military requirements is a priority for the EU and its Member States, being the starting point for an effective Union-wide approach, enveloping all the actions defined in the other two key areas.

The second area of interest, of transport infrastructure, makes direct reference to infrastructure and investment policy, in order to create opportunities for a symbiosis between the civilian and the military needs. In 2019, the Commission nominated by the European Defence Agency developed a report on the parts of the trans-European transport network that are suitable for military transport, including suggestions for the necessary adaptations to the existing infrastructure (e.g., airport facilities, height or load-bearing capacity of bridges etc.). The Member States agreed on the need for priority projects and approved additional financial support for these major projects (Tibil, 2018). This project will support the Member States' commitment to simplify and standardise the cross-border military transport



ROMANIAN
MILITARY
THINKING

The action plan on military mobility was developed within the European Defence Agency, suggesting practical actions in the following key areas: military requirements, transport infrastructure and regulatory and procedural issues.

Identifying and reaching an agreement on military requirements is a priority for the EU and its Member States, being the starting point for an effective Union-wide approach, enveloping all the actions defined in the other two key areas.



The pilot exercise also identified the opportunities offered by dual-use civilian military infrastructure, in particular the facilities represented by standard transport platforms and containers, which allow efficient mobility of goods within the transport infrastructure, regardless of ports, airports, railways or roads, a decisive role being played by the standardisation of loading gauges.

procedures. It aims to increase the speed of the military forces across Europe. Its purpose is to ensure the unrestricted movement of the military personnel and assets within EU borders. This means avoiding lengthy bureaucratic procedures for travelling through or between EU Member States, whether by rail, road, air or sea. The project should help reduce barriers, such as legal obstacles to cross-border traffic, persistent bureaucratic requirements (such as passport checks at some border crossings) and infrastructure problems, such as roads and bridges that cannot bear large military vehicles (PESCO, 2021).

In the spirit of the above, transport infrastructure policies offer a clear opportunity to combine the defence needs with the existing policies at EU level, especially in the field of trans-European transport. A pilot analysis made by Estonia had a remarkable practical importance in this field, aiming at the trans-European transport network in the Baltic Sea area. This pilot analysis proved to be very useful, with the Member States participating in the exercise underlying this analysis, identifying the weaknesses in their transport networks assigned for military purposes and the requirements to develop these networks. EU road networks, the maximum height of road bridges and the maximum allowable weight of certain bridges are not sufficient for certain military oversized vehicles. Similarly, with regard to rail transport, certain situations have been identified, which have resulted in limitations on the cargo and transport capacity of large military equipment. Last but not least, the pilot exercise also identified the opportunities offered by dual-use civilian military infrastructure, in particular the facilities represented by standard transport platforms and containers, which allow efficient mobility of goods within the transport infrastructure, regardless of ports, airports, railways or roads, a decisive role being played by the standardisation of loading gauges.

The regulatory and procedural issues covered by the third area of interest refer directly to the identification of variants that would be unanimously accepted by the Member States for streamlining and simplifying the customs formalities specific to the military operations and the need to reassess the alignment of regulations on the transport of dangerous goods in the military field. In parallel, the European Defence Agency has been designated as the structure responsible

for supporting the Member States in developing mechanisms for cross-border movement authorisations. Important issues are covered in this area, such as those relating to dangerous goods, customs duties and value added taxes.

Land transport of dangerous goods is an area in which the European Commission and the EU Member States are actively involved in negotiating a complex set of international conventions and recommendations made by the UN. Although they are applied only to civilian use, those particular ways of applying the national rules when requiring freedom of movement for military transport, including dangerous goods (ammunition, explosives etc.) must be found. Certain civil proceedings require legislative revisions regarding the granting of special authorisations in order to avoid possible delays in the mobility of military transport.

Customs duties and value added taxes are another set of problems in the regulatory aspects, which require timely solutions so as not to impede military mobility. In this regard, appropriate solutions must be found to the difficulties identified in the legislative framework regarding the export and import of military goods by or for the benefit of the various armed forces in the EU Member States. Military mobility may also require the transport of certain fuels, food, training materials, military equipment etc., which are subject to value added tax under local law.

The joint actions in the three areas presented above and the intense cooperation between the EU and NATO have led to the development of a wide range of tools to provide adequate security for the citizens of Europe and beyond. Thus, on 10 July 2018, the EU and NATO signed a new joint statement by which they agreed on a common vision of how the two entities will act together against common security threats. At the same time, the areas on which the EU-NATO cooperation will focus have been established, namely: military mobility, cyber security, hybrid threats, counter-terrorism, women and security.

It is worthwhile mentioning that although NATO initially campaigned for a position of cooperation with the EU on how to develop military mobility, NATO has meanwhile changed its approach to these efforts, amid new visions for the development of a common European defence,



ROMANIAN
MILITARY
THINKING

Customs duties and value added taxes are another set of problems in the regulatory aspects, which require timely solutions so as not to impede military mobility. In this regard, appropriate solutions must be found to the difficulties identified in the legislative framework regarding the export and import of military goods by or for the benefit of the various armed forces in the EU Member States.



considering the EU's efforts to establish an armed force to be a step forward towards creating a “competitive” structure with NATO, which risks weakening and dividing the North Atlantic Alliance.

Last but not least, we consider that the actions of the European states in terms of military mobility have been on a downward trend, due to the problems caused by the new Coronavirus, with the national efforts focusing on public health, with the use of the available resources, including of the military, to limit and eradicate this pandemic.

MILITARY MOBILITY FROM A NATIONAL PERSPECTIVE

From a national perspective, we have a well-defined *mobility–force protection* binomial, which has a decisive role in achieving freedom of manoeuvre and defending one's own forces from the possible enemy actions and/or against the adversities of nature. Achieving mobility directly refers to approaches to: overcoming various obstacles, manoeuvring in the tactical field, ensuring the viability of roads and identifying routes to bypass inaccessible areas.

We consider that the actions of the European states in terms of military mobility have been on a downward trend, due to the problems caused by the new Coronavirus, with the national efforts focusing on public health, with the use of the available resources, including of the military, to limit and eradicate this pandemic.

Military mobility in Romania, approached from a multinational context, must address some important aspects regarding: the configuration of the land in the border area and the possibilities of conducting land manoeuvre (relating to mobility in the west versus mobility in the south), ensuring the conditions and possibilities for airports for air manoeuvring and, last but not least, for naval mobility in the Black Sea and the Danube areas.

The possibility of performing land manoeuvre brings with it the advantage of a rapid flow of military equipment on wheels, regardless of the size of the subunits/units/task forces, compared to the naval or air manoeuvre. For example, the execution of a manoeuvre by an armour or artillery battalion in the southern border area, analysed from the land and naval perspectives, can bring different manoeuvre times, with major influences on the success of the operations in which these forces are planned to participate. Specifically, the execution of the manoeuvre by a battalion of towed or self-propelled artillery on wheels, in case the Danube is crossed over the Ruse-Giurgiu Bridge, with a speed of 30 km/h, can be achieved in maximum 30 minutes.

If the passage of the same artillery unit is done by means of specialised military ships (e.g., ships provided by a battalion of river crossings), the crossing times would be very long compared to land mobility, which can lead to belatedly using the forces in planned military operations. For example, at least five heavy river crossing ships are required for the passage of an artillery battalion. If we add up the time required to embark with the time required for the crossing and the disembarkation time, given that the embarkation and disembarkation areas do not always ensure the possibility of anchoring all transport vessels simultaneously, we reach a total time of approximately 120 minutes, concluding that the total passage time is much longer than the passage time on wheels.

In the process of analysing military mobility on the national territory, we consider that a relevant analysis must also be made in the case of Dobruja, a geographical area to/from which military and civilian mobility is largely ensured by the Anghel Saligny Bridge and, in the near future, by the Brăila-Smârdan Bridge. We believe that this analysis must also be made in the situation where military mobility cannot be materialised from the perspective of using these bridges, being necessary, at some point, to manoeuvre land forces using floating bridges or river crossings with crossing ships/ferries. These are aspects that we consider important, and in the situations mentioned above, a decisive role will be played by the specialised engineering units, which will be responsible for building floating bridges or using specialised ships, otherwise military planners may face real problems ensuring mobility of the forces in this eastern part of the country.

The construction of a floating bridge over the Danube requires appreciable logistics, a fairly long construction time and, last but not least, forces to maintain its viability, both from a constructive point of view and from the force protection perspective. We consider this variant to be optimal in large-scale military exercises, which involve a significant number of military structures that are engaged in the river crossing. The exercises of building such a facility are essential for maintaining skills and putting them into practice when the situation requires it.



ROMANIAN
MILITARY
THINKING

At least five heavy river crossing ships are required for the passage of an artillery battalion. If we add up the time required to embark with the time required for the crossing and the disembarkation time, given that the embarkation and disembarkation areas do not always ensure the possibility of anchoring all transport vessels simultaneously, we reach a total time of approximately 120 minutes, concluding that the total passage time is much longer than the passage time on wheels.



The Saber Guardian 2017 and Saber Guardian 2019 exercises highlighted the importance of floating bridges over the Danube. In the Saber Guardian 2019 exercise, a training sequence was represented by the Scorpions Fury (Soare, 2019) exercise, its scenario involving appreciable armed land, air and naval forces, in an area considered “vulnerable” and of critical importance for Romania and the NATO space: the banks of the Danube.

The *Saber Guardian 2017* and *Saber Guardian 2019* (the largest NATO exercise in Romania, coordinated by the Romanian and American armed forces) exercises highlighted the importance of floating bridges over the Danube. For example, in the *Saber Guardian 2019* exercise, a training sequence was represented by the *Scorpions Fury* (Soare, 2019) exercise, its scenario involving appreciable armed land, air and naval forces, in an area considered “vulnerable” and of critical importance for Romania and the NATO space: the banks of the Danube. In this scenario, the construction of a floating bridge with a length of 2000 m was successfully completed. The bridge was successfully crossed by over 200 vehicles and fighting equipment.

The *Saber Guardian 2017* exercise was part of a similar scenario, in which a highway was built on water, with three lanes of traffic: the middle one, used by the tanks, which could stand a weight of up to 40 tons, and the side ones, with the possibility of bearing 20 tons each.

Another noteworthy aspect is that in the case of floating bridges the travel speed is very low (5 - 10 km/h), the military planners being forced to develop a well-established schedule of the crossing, so that the crossings of different military subunits are achieved safely, in compliance with all speed, tonnage and distance requirements during transit.

Analysing the mobility facilities using floating bridges, we can conclude that they are very useful, but the volume of activities, the personnel involved, the duration and the logistics required are a huge effort for the structures responsible for building and maintaining their viability.

We believe that mobility must be approached from all points of view, as a careful analysis of how to increase manoeuvrability, from the perspective of land, air and naval mobility. The equipment of the Romanian armed forces with modern weapons systems [HIMARS (Cozmei, 2021), Patriot], with major influences in increasing fire support capabilities, can also raise problems in the field of mobility, problems that result when the respective military structures have to execute the manoeuvre in different areas, with direct reference to the overall dimensions, possibilities to cross certain bridges etc.

From a land forces perspective, a relevant example for the mobility of forces on the national territory is the area of the Cincu firing range. Specifically, in order to ensure the access of the forces participating in the national or multinational exercises in the largest land forces firing range in our country, some limitations in the field of mobility have been identified, with influences on the times and possibilities of embarking/disembarking military equipment in Voila railway station and the existence of tonnage limitations for the bridge over the Olt River, in the same locality. In order to increase mobility, the necessary steps have been initiated and, in partnership with the US military, a new embarkation/disembarkation ramp has been built in Voila railway station, and work is currently underway to build a new bridge over the Olt River, allowing the passage of oversized military equipment.

We consider that the problems regarding mobility at national level are complex, and the relief features have a major influence, given that our country has about 30% mountainous area, a hydrological network with many rivers that can form natural obstacles, and a southern area with a complex network of hydro-improvement works, with a significant number of bridges, footbridges and tunnels. All these are challenges for the military planners, and solving the problems of land, air or naval mobility can be done, in our opinion, using the mathematical approach, with direct reference to methods and models of analysis and decision-making, so that the courses of action analysed by the military planners can be very well founded.

MATHEMATICAL DECISION-MAKING MODELS FOR ESTABLISHING THE OPTIMAL MOBILITY VARIANTS

In order to choose an optimal mobility variant, we can use one of the decision-making models under certainty or uncertainty conditions, using different analysis criteria for the approached study. The mathematical analyses can be applied in the military field as well, where the different elements/data/ reference characteristics can be taken into account for solving the problem directly referring to the military equipment involved, the personnel, the costs, the missions, and so on.



ROMANIAN
MILITARY
THINKING

The problems regarding mobility at national level are complex, and the relief features have a major influence, given that our country has about 30% mountainous area, a hydrological network with many rivers that can form natural obstacles, and a southern area with a complex network of hydro-improvement works, with a significant number of bridges, footbridges and tunnels.



We suggest a real example of making a decision under certainty conditions, required by the conduct of a comprehensive analysis on choosing the optimal variant for crossing the Danube by a Land Forces Task Force consisting of units and subunits of NATO member countries, assigned to participate in a multinational exercise on the territory of our country, given the existence of terrorist threats in the area of the southern border, where we will use the method of moments, one of the most widely used methods of decision-making under certainty conditions.

The decisions made under certainty conditions are the most viable, the results being characterised by accuracy, but they require having data and information as precise as possible about the features used in the analysis.

In this regard, we suggest a real example of making a decision under certainty conditions, required by the conduct of a comprehensive analysis on choosing the optimal variant for crossing the Danube by a Land Forces Task Force consisting of units and subunits of NATO member countries, assigned to participate in a multinational exercise on the territory of our country, given the existence of terrorist threats in the area of the southern border, where we will use *the method of moments*, one of the most widely used methods of decision-making under certainty conditions.

Several variants of crossing the Danube in the Ruse-Giurgiu area were taken into account in order to solve this problem, as follows:

- V1 – the river is crossed over the Ruse-Giurgiu friendship bridge;
- V2 - the river is crossed by means of specialised ships/ferries, using the port facilities in the towns of Ruse and Giurgiu;
- V3 - the river is crossed over a floating bridge built in the Ruse-Giurgiu area.

The criteria taken into account to solve the problem are the following:

- C1 – the passage time;
- C2 – the personnel involved;
- C3 – the costs;
- C4 – the protection of forces during passage.

The first step in solving this analysis is to establish the criteria that need to be maximised or minimised, so as to obtain a *consequence matrix* based on the *minimum/maximum* criteria of the following form:

Criteria/ Variant	C1 <i>min/max</i>	C2 <i>min/max</i>	C3 <i>min/max</i>	C4 <i>min/max</i>
V1	a_{11}	a_{12}	a_{13}	a_{14}
V2	a_{21}	a_{22}	a_{23}	a_{24}
V3	a_{31}	a_{32}	a_{33}	a_{34}

where, a_{11} , a_{12} , to a_{34} are values corresponding to the established C1, C2, C3, C4 criteria.

The next step is to transform the consequence matrix into a *normalised matrix*, using the following *minimum-maximum relationships*:

$$r_{min} = \frac{a_{max} - a}{a_{max} - a_{min}}$$

$$r_{max} = \frac{a - a_{min}}{a_{max} - a_{min}}$$

where,

a_{max} = the highest value in the consequence matrix, corresponding to the analysed criterion;

a_{min} = the lowest value in the consequence matrix, corresponding to the analysed criterion;

a = the analysed element in the consequence matrix.

By entering the values corresponding to the criteria established in the consequence matrix, and taking into account the fact that for criteria C1, C2 and C3 the optimum is obtained if they tend towards the minimum and C4 towards the maximum, we will have the following consequence matrix:

Criteria/Variant	C1 <i>min</i>	C2 <i>min</i>	C3 <i>min</i>	C4 <i>max</i>
V1	15	10	50	10
V2	100	100	200	70
V3	30	200	250	50

By applying the minimum-maximum ratios, we will obtain the following normalised matrix:

Criteria/Variant	C1 <i>min</i>	C2 <i>min</i>	C3 <i>min</i>	C4 <i>max</i>
V1	1	1	1	0
V2	0	0.52	0.25	1
V3	0.76	0	0	0.66

For example, the values in the above normalised matrix were determined as follows:

- a) for the element corresponding to Criterion 1 of Variant 1, the *minimum relation* was applied, with the following result:

$$r_{min} = \frac{a_{max} - a}{a_{max} - a_{min}} = \frac{100 - 15}{100 - 15} = 1$$



b) for the element corresponding to Criterion 4 of Variant 3, the *maximum relation* was applied, with the following results:

$$r_{min} = \frac{a - a_{min}}{a_{max} - a_{min}} = \frac{50 - 10}{70 - 15} = 0,66$$

Then, the moments corresponding to the lines of the normalised matrix were calculated using the formula:

$$M = (1 \cdot a_1 + 2 \cdot a_2 + \dots + n \cdot a_n) / (a_1 + a_2 + \dots + a_n)$$

Applying this formula, we obtain:

$$M_{1/V1} = (1 \cdot 1 + 2 \cdot 1 + 3 \cdot 1 + 4 \cdot 0) / (1 + 1 + 1 + 0) = 6/3 = 2$$

$$M_{2/V2} = (1 \cdot 0 + 2 \cdot 0.52 + 3 \cdot 0.25 + 4 \cdot 1) / (0 + 0.52 + 0.25 + 1) = 5.79/1.77 = 3.27$$

$$M_{3/V3} = (1 \cdot 0.76 + 2 \cdot 0 + 3 \cdot 0 + 4 \cdot 0.66) / (0.76 + 0 + 0 + 0.66) = 3.4/1.42 = 2.39$$

The next step is to rearrange the normalised matrix lines in ascending order, depending on the values of the above determined moments M1, M2 and M3. Thus, we obtain the following matrix:

Criteria/Variant	C1 <i>min</i>	C2 <i>min</i>	C3 <i>min</i>	C4 <i>max</i>
V1	1	1	1	0
V3	0.76	0	0	0.66
V2	0	0.52	0.25	1

In order to determine the optimal variant, the moments corresponding to the columns of the rearranged normalised matrix will be further calculated:

$$M_{1/C1} = (1 \cdot 1 + 2 \cdot 0.76 + 3 \cdot 0) / (1 + 0.76 + 0) = 2.52/1.76 = 1.43$$

$$M_{2/C2} = (1 \cdot 1 + 2 \cdot 0 + 3 \cdot 0.52) / (1 + 0 + 0.52) = 2.56/1.52 = 1.68$$

$$M_{3/C3} = (1 \cdot 1 + 2 \cdot 0 + 3 \cdot 0.25) / (1 + 0 + 0.25) = 1.75/1.25 = 1.4$$

$$M_{4/C4} = (1 \cdot 0 + 2 \cdot 0.66 + 3 \cdot 1) / (0 + 0.66 + 1) = 4.32/1.66 = 2.60$$

After determining the moments corresponding to the columns, the normalised matrix is rearranged with the columns in ascending order, as follows:

Criteria/Variant	C3 <i>min</i>	C1 <i>min</i>	C2 <i>min</i>	C4 <i>max</i>
V1	1	1	1	0
V3	0	0.76	0	0.66
V2	0.25	0	0.52	1

After each rearrangement of the columns, a new calculation of the moments is required. It will be done according to line, specific to variants V1, V2 and V3. This gives the following values:

$$M_{1/V1} = (1 \cdot 1 + 2 \cdot 1 + 3 \cdot 1 + 4 \cdot 0) / (1 + 1 + 1 + 0) = 6/3 = 2$$

$$M_{2/V3} = (1 \cdot 0 + 2 \cdot 0.76 + 3 \cdot 0 + 4 \cdot 0.66) / (0 + 0.76 + 0 + 0.66) = 4.16/1.42 = 2.92$$

$$M_{3/V2} = (1 \cdot 0.25 + 2 \cdot 0 + 3 \cdot 0.52 + 4 \cdot 1) / (0.25 + 0 + 0.52 + 1) = 5.81/1.77 = 3.28$$

In the event of changes in the values of the moments determined above, the lines of the normalised matrix would be rearranged in ascending order, followed by a recalculation of the moments of the columns. In our example it is observed that the lines do not undergo changes, which means that the last matrix is the correct variant and, consequently, Variant 1 is the optimal variant, which could underlie the decision of selecting how the Land Forces Task Group would cross the Danube, by taking all the necessary measures to protect the forces and counter possible terrorist action affecting the crossing of the bridge.

We believe that these types of analyses are particularly important, leading to mathematically sound results and facilitating the decision-making process. Also, military mobility, which involves developing rigorous plans, thorough calculations and identifying viable solutions for many constraints (bridge capacity, height limitations, transport capability etc.) can be approached mathematically, and the results obtained will certainly be optimal elements compared to other types of analysis.

CONCLUSIONS

We consider that the initiatives to increase military mobility at European level represent an important step in the process of ensuring regional security, in the context of the existence of threats and vulnerabilities brought to the fore by the regional conflicts or the issues that have not been discussed so far, with direct reference to migration or various incidents at the NATO or EU border.

All the working groups set up at European level approach the European military mobility with full consideration for the sovereignty of the EU Member States over their national territory and the national



ROMANIAN
MILITARY
THINKING

In our example it is observed that the lines do not undergo changes, which means that the last matrix is the correct variant and, consequently, Variant 1 is the optimal variant, which could underlie the decision of selecting how the Land Forces Task Group would cross the Danube, by taking all the necessary measures to protect the forces and counter possible terrorist action affecting the crossing of the bridge.



All the working groups set up at European level approach the European military mobility with full consideration for the sovereignty of the EU Member States over their national territory and the national decision-making procedures for military manoeuvre. Moreover, the steps to improve cooperation between the institutions, agencies and bodies of the European Union and the national authorities of the EU Member States must be taken in full compliance with the various legislative peculiarities of the signatory countries.

decision-making procedures for military manoeuvre. Moreover, the steps to improve cooperation between the institutions, agencies and bodies of the European Union and the national authorities of the EU Member States must be taken in full compliance with the various legislative peculiarities of the signatory countries.

In our opinion, the continuation of the cooperation with NATO in the field of military mobility is also an important issue, Romania being a member of the Alliance. In accordance with the conclusions presented to the Council of Europe, we consider it essential to further the efforts of cooperation and consultation with NATO at the level of decision-makers, through regular meetings on military mobility issues in all areas (land, sea, air). In this way, a coherent and unified approach between the EU and NATO can be ensured in order to identify and remove the existing barriers, including the legal, infrastructure and procedural ones, in order to facilitate and accelerate the movement and crossing of borders by the personnel and equipment participating in various exercises, in full compliance with the laws of each state. This cooperation may be continued open-mindedly and transparently, respecting the decision-making autonomy and the procedures specific to both organisations, without prejudice to the specific nature of the guarantee and the defence policies of the Member States.

Last but not least, the multitude of variables and limitations that can occur in the process of analysing and increasing mobility require scientific approaches, with direct reference to mathematical models, whose applicability can help find solutions which can lead to well-founded decisions to efficiently ensure the success of the military operations or exercises.

BIBLIOGRAPHY:

1. Bădălan, E., Arsenie, V., Văduva, Gh. (2006). *Strategie militară contemporană*. București: Editura Centrului Tehnic-Editorial al Armatei.
2. Bălăceanu, I. (2003). *Câmpul de luptă modern sub impactul tehnologiilor contemporane*. București: Editura ARS DOCENDI.
3. Bălăceanu, I., Dumitru, D., Ioana, I. (2006). *Potențialul de luptă al forțelor terestre în context NATO*. București: Editura Top Form.

4. Bălăceanu, I., Râpan, F., Hanganu, M., Martin, I., Dragomirescu, V., Mureșan, D. (2010). *Interacțiunea strategiilor în conflictele armate moderne*. București: Editura Universității Naționale de Apărare “Carol I”.
5. Bușe, D. (2012). *Geopolitică și Geostrategie*. București. Editura Universității Naționale de Apărare “Carol I”.
6. Căruțașu, V., Bîrsan, G. (2006). *Aplicații ale modelării și simulării acțiunilor militare*. Sibiu: Editura Academiei Forțelor Terestre “Nicolae Bălcescu”.
7. Căruțașu, V., Răchițan, D. (2000). *Variabile aleatoare și aplicații*. Sibiu: Editura Universității “Lucian Blaga”.
8. Cozmei, V. (2021), <https://www.hotnews.ro/stiri-defense-24620203-primul-sistem-rachete-himars-ajuns-romania-dotarea-mapn-foto.htm>, retrieved on 10 October 2021.
9. Mureșan, M., Văduva, Gh. (2004). *Războiul viitorului, viitorul războiului*. București: Editura Universității Naționale de Apărare “Carol I”.
10. Petre, C. (2011). *Cadrul operațional contemporan și transformarea militară*. București: Editura Universității Naționale de Apărare “Carol I”.
11. Rumer, E. (2021). *Even a Major Military Exercise Like Zapad Can't Fix Some of the Biggest Security Challenges Facing Russia*, <https://carnegieendowment.org/2021/09/21/even-major-military-exercise-like-zapad-can-t-fix-some-of-biggest-security-challenges-facing-russia-pub-85397>, retrieved on 10 October 2021.
12. Soare, A. (2019). *S-a dat startul exercițiului Scorpions Fury 19*, in *Monitorul Apărării și Securității*, <https://monitorulapararii.ro/s-a-dat-startul-exercițiului-scorpions-fury-19-1-17001>, retrieved on 10 October 2021.
13. Toffler, A. and H. (1995). *Război și anti-război – supraviețuirea în zorii secolului XXI*. București: Editura Antet.
14. *Carta Albă a Apărării* (2021). București.
15. European Council (2021), <https://www.consilium.europa.eu/ro/policies/defence-security/>, retrieved on 10 October 2021, Ministry of National Defence, 2020, Retrospective 2019 - Saber Guardian 19, <https://armed.mapn.ro/retrospectiva-2019---saber-guardian-19-2612-26>, retrieved on 10 October 2021.
16. *Defending Europe: Improving Military Mobility in the European Union* (2018), European Commission fact sheet.
17. *Doctrina planificării operațiilor în Armata României* (2013). București.



18. *Doctrina pentru operații întrunite a Armatei României* (2014). București.
19. *Doctrina operațiilor forțelor terestre* (2017). București.
20. *Doctrina sprijinului de geniu în operațiile întrunite* (2016). București.
21. NATO Media Information Centre (2021). *Exercise Noble Jump 2021 Begins in Romania*, <https://shape.nato.int/steadfast-defender/newsroom/news/exercise-noble-jump-2021-begins-in-romania>, retrieved on 10 October 2021.
22. PESCO (2021), <https://www.consilium.europa.eu/media/32079/pesco-overview-of-first-collaborative-of-projects-for-press.pdf>, retrieved on 10 October 2021.
23. *European Parliament Resolution on EU-NATO relations*, June 2018.
24. *European Union Global Strategy for Foreign and Security Policy*, June 2016.
25. *National Defence Strategy 2020-2024* (2020). București.
26. *Brussels Treaty* (2018), <https://eur-lex.europa.eu/legal-content/RO/TXT/?uri=LEGISSUM%3A4301863>, retrieved on 10 October 2021.
27. *NATO Treaty* (1949), <http://www.mae.ro/sites/default/files/file/pdf/TRATATUL%2520NORD-ATLANTIC.pdf>, retrieved on 10 October 2021.
28. <https://armed.mapn.ro/retrospectiva-2019---saber-guardian-19-2612-26>, retrieved on 12 October 2021.
29. <https://eur-lex.europa.eu/legal-content/RO/TXT/?uri=LEGISSUM%3A4301863>, retrieved on 23 October 2021.
30. <https://europedirect-tm.ro/stiri-ue/uniunea-in-domeniul-apararii-mobilitate-militara-in-interiorul-si-in-afara-ue>, retrieved on 12 October 2021.
31. https://function.mil.ru/news_page/country/more.htm?id=12381883@egNes, retrieved on 23 October 2021.
32. <https://monitorulapararii.ro/pesco-momentul-adevarului-pentru-apararea-europeana-1-1438>, retrieved on 25 September 2021.
33. <https://monitorulapararii.ro/s-a-dat-startul-exercitiului-scorpions-fury-19-1-17001>, retrieved on 23 October 2021.
34. <https://shape.nato.int/steadfast-defender/newsroom/news/exercise-noble-jump-2021-begins-in-romania>, retrieved on 23 October 2021.
35. <https://www.armyacademy.ro/biblioteca/anuare/2004/a42.pdf>, retrieved on 23 October 2021.
36. <https://www.consilium.europa.eu/ro/policies/defence-security/>, retrieved on 23 October 2021.
37. <https://www.defenseromania.ro/>, retrieved on 12 October 2021.

38. <https://www.digi24.ro/stiri/externe/mapamond/seful-nato-critica-eforturile-ue-de-a-crea-o-armata-europeana-nu-numai-ca-va-slabi-nato-ci-va-diviza-si-europa-1691467>, retrieved on 23 October 2021.
39. <https://www.hotnews.ro/stiri-defense-24620203-primul-sistem-rachete-himars-ajuns-romania-dotarea-mapn-foto.htm>, retrieved on 23 October 2021.
40. <http://www.mae.ro/sites/default/files/file/pdf/TRATATUL%2520NORD-ATLANTIC.pdf>, retrieved on 12 October 2021.



ROMANIAN
MILITARY
THINKING