ENHANCING OPERATIONAL LOGISTICS IN RESPONSE TO UKRAINE WAR IMPACTS: A RELATIONAL ANALYSIS

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The armed conflict in Ukraine represented a significant test for the efficiency of operational logistics, highlighting both the strengths and vulnerabilities in resource management and the coordination of operations under conditions of uncertainty and instability. The challenges encountered by the forces involved provided valuable lessons about the need for a flexible, rapidly adaptable, and well-integrated logistics system, capable of responding efficiently and coherently to the requirements imposed by the dynamics of a protracted conflict.

The article proposes an analysis focused on improving the functioning of operational logistics in the context of inter-organizational and intra-organizational relations within an area or theater of operations in which NATO operational forces with national and multinational status are engaged. The study examines how logistics structures will have to respond to the challenges and difficulties that may arise in the future in a high-intensity conflict such as the one in Ukraine. In this regard, we have identified key aspects with an impact on operational efficiency. In addition, we have proposed some applicative solutions for optimizing logistics processes, including the implementation of advanced technologies, adaptability, and flexibility in the face of unpredictable situations. The conclusions emphasize the need to implement innovative concepts that would improve operational logistics integrated into the combat structures of NATO states in future conflicts, providing a framework for the development of more efficient and sustainable practices in managing resources in crisis conditions.

Key words: *armed conflict; combat forces; operational logistics; improvement; mobility; sufficient resources; logistics resilience.*

1. INTRODUCTION

The future security environment will be increasingly complex, driven by the impact of new military technologies on the battlefield. The most disruptive technologies are not always the most advanced. Artificial intelligence (AI) and machine learning (ML) are good examples of this lesson, as relatively simple models have enabled the proliferation of inexpensive unmanned weapons systems and improvements in military decision-making [1]. The ongoing challenges to the international regulatory order and the manifestation of long-term strategic competition between the main global actors. Therefore, the future operational environment will be characterized by a modernized infrastructure, complex and dynamic operating methods, integrating technologies, equipment, automated and robotic systems, artificial intelligence, as well as advanced planning and action procedures. Under these conditions, both for NATO and national forces, operational logistics will need to have the capability and protection necessary to provide adequate logistical support to multi-domain, non-linear, and/or expeditionary operations conducted at greater distances, due to the context and complexity of the threats specific to the future confrontation environment [2].

The complication of regional and international security, as a result of Russian aggression in Ukraine, has led NATO bodies to carry out successive decision-making processes to increase the response force, as well as the related operational logistics. The high-intensity armed conflict in the vicinity of NATO's eastern flank (southeastern area) led to the establishment and implementation of measures to deter the aggressor state. To this end, the new NATO force model (New Force Model - NFM) was adopted at the Madrid Summit in 2022. It allowed the Allies to: deploy more forces in Eastern Europe by building eight Battle Groups [3]; agreeing on the implementation of new military training and defense plans; conducting more exercises; significantly improving NATO capabilities in the High North and the Baltic Region, following the accession of Finland and Sweden in 2023 and 2024 respectively to the Alliance; increasing military readiness to increase deterrence and, if necessary, defeat further Russian aggression [4].

At the same time, the NFM has significantly expanded the number of highly trained forces, as well as the follow-up forces available to NATO commanders. Thus, if before 2022, the NATO Response Force had the capacity to deploy approximately 40,000 soldiers at the Allied level in

less than 15 days, through the NFM the Alliance intends to achieve the strategic objective (through specific training actions) appropriate to the deployment of over 100,000 soldiers (Level 1 Forces) in a maximum period of ten days [5] (Figure 1).

In this sense, Figure 2 is suggestive, which reveals a conception of the "Iron Triangle" appropriate to NATO's specific deterrence and defense actions, involving the appropriate forces and means, as well as the necessary

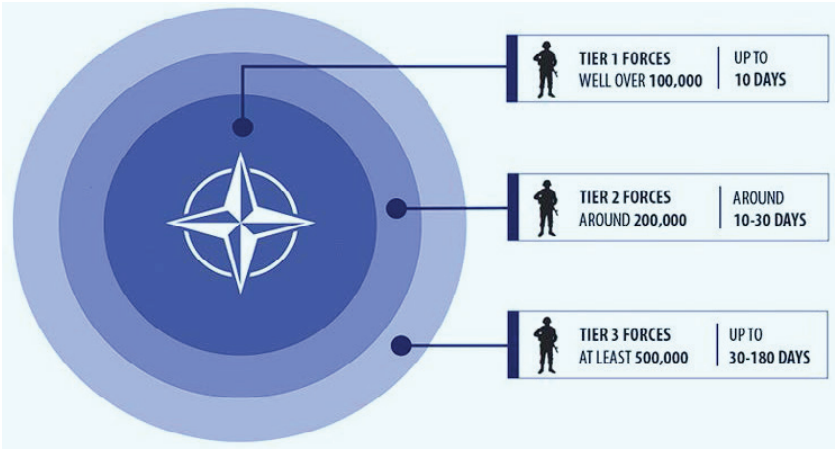

Fig. 1 An image on NATO's New Force Model [4]

The progress made by European NATO member states since February 2022 to date in adapting their forces to face a high-intensity war against Russia is significant. Military analysts believe that these countries need to redirect their efforts to support future actions, with a focus on the ability to fight and sustain operations over the long term. In this context, Alliance states need to intensify their preparation, improve mobility, and eliminate critical gaps in defense capabilities. Also, strengthening the defense industrial base and generating sustainable financial flows are key elements for future success [3].

operational logistical support. We appreciate that, in a high-intensity conflict, for the success of NATO combat and support forces, it is necessary to increase the performance of operational logistics at the joint and tactical levels to provide continuous support for defensive or offensive operations within the allied framework. Moreover, modern operational logistics must adapt quickly to the requirements of a dynamic security environment, characterized by protracted conflicts, with increasing requirements for high mobility and viable and sufficient resources.

Fig. 2 A relevant concept of increasing resilience appropriate for deterring adversaries and defending the Alliance [3]

To meet current operational challenges, military experts believe that NATO member states must strengthen their supply chains, including transport and storage infrastructure, to ensure the rapid and efficient transfer of equipment and resources between areas or theaters of operations. In this regard, effective interoperability and coordination between the different forces of the Alliance are fundamental. It follows that the standardization of equipment, communications, and operational procedures between member states' forces will allow for their better integration into a common system, thus facilitating the rapid and efficient mobilization of personnel and logistical resources (of material, financial, and informational nature) [6].

Another critical point is, from our point of view, the development of cyber defence capabilities and the protection of logistical networks from external attacks or sabotage. With the rapid evolution of technologies, data protection, and communication security become vital to maintain a constant flow of information and materials. In addition, Member States need to invest in advanced technological solutions, including drones, satellite monitoring systems, and automation in logistics management, to improve efficiency and reduce reliance on human resources in a protracted conflict.

In parallel, the development of a robust defense industrial base is essential to sustain operations in the long term. This must not only meet immediate needs, but also ensure the continuous production of equipment, munitions, and technology, which is essential in a large-scale conflict.

The creation of partnerships between the public and private sectors can stimulate innovation and flexibility in the defense industry, allowing rapid reactions to emerging operational needs. These partnerships can also include expanding collaboration with non-military industries to rapidly adapt production solutions to the requirements of a modern conflict [6].

Regarding the financial sustainability of long-term operations, according to the experts' assessment, NATO countries must review their budget structures and ensure constant and flexible financial flows to support defense efforts. This requires an efficient allocation of resources and greater transparency in the management of funds intended for the defense sector. Collaboration within the Alliance, in particular through common financing mechanisms, will contribute to a better distribution of costs and reduce the pressure on individual budgets of member states [3].

Thus, we believe that to meet the challenges of high-intensity warfare, NATO countries will need to combine advances in operational logistics with greater flexibility, coordination, and financial sustainability. This requires an integrated approach that ensures both the rapid mobilization of resources and the necessary long-term support for Alliance military forces, regardless of the duration and intensity of the conflict.

Starting from several directions that we propose, for the continuous improvement of operational logistics, we developed five subsequences within the second sequence, thus managing to appropriately develop in content all the elements in Figure 3. To this end, we used a combination of analytical, inductive, deductive and comparative methodological tools.

2. ELEMENTS OF INCREASING THE PERFORMANCE OF OPERATIONAL MILITARY LOGISTICS

The continuous and rapid development of military equipment that is and will be at the disposal of NATO national and multinational combat forces has a major impact on operational logistics. This determines that logistics managers and their subordinates, from the strategic level to the lower tactical level, to act in the direction of implementing logistics principles and functions according to the new operational requirements identified from the lessons learned resulting from the conduct of the armed conflict in the theater of violent confrontations in Ukraine.

The accumulation of modern equipment by operational structures

and as a result of the aforementioned identified lessons, will determine new challenges for management and execution logisticians. In this sense, areas of logistical support will be involved, such as supply, maintenance, movement and transport, which will be correlatively and systemically engaged to ensure the consumption of materials necessary for operation, the provision of maintenance services, as well as for their timely movement to the area/theater of operations, but also within it.

In full agreement with the concept of transforming the Alliance's functions, operational logistics represents a system of systems, capable of anticipating and solving the requirements of the forces on which the evolution of joint and tactical situations will depend. In this sense, the support requirements (national and/or multinational) define even more precisely the role and importance of operational logistics (especially for the United States, Great Britain, and France), due to its expeditionary nature depending on the missions of the forces constituted by NATO states, also taking into account the experience of past campaigns in Iraq and Afghanistan [7]. Moreover, the destructive offensive actions, the challenges, and the consequences related to the Russian army's invasion of Ukraine have determined both on the part of the invaded state and on the part of the member countries of the North Atlantic Alliance, combined actions appropriate to the structural and functional reorganization and increase of the resilience of the combat forces, as well as of the specific operational logistics [8].

Therefore, the essential directions (objectives) revealed in Figure 3 aim at: *the organizational reconfiguration of logistics forces; the (overall) increase in operational logistics performance through the adequate modernization of its functional areas; the adequate planning of operational logistics with national and multinational status; the concretization in new conditions of resilience and risk management specific to operational logistics; the concretization of new requirements both in the field of training and in that of improving the training of officers who will perform leadership or execution duties of logistical support* [9]. All of these will be developed briefly, further, in a manner appropriate to the new requirements resulting from the lessons identified, as a result of the armed conflict in Ukraine.

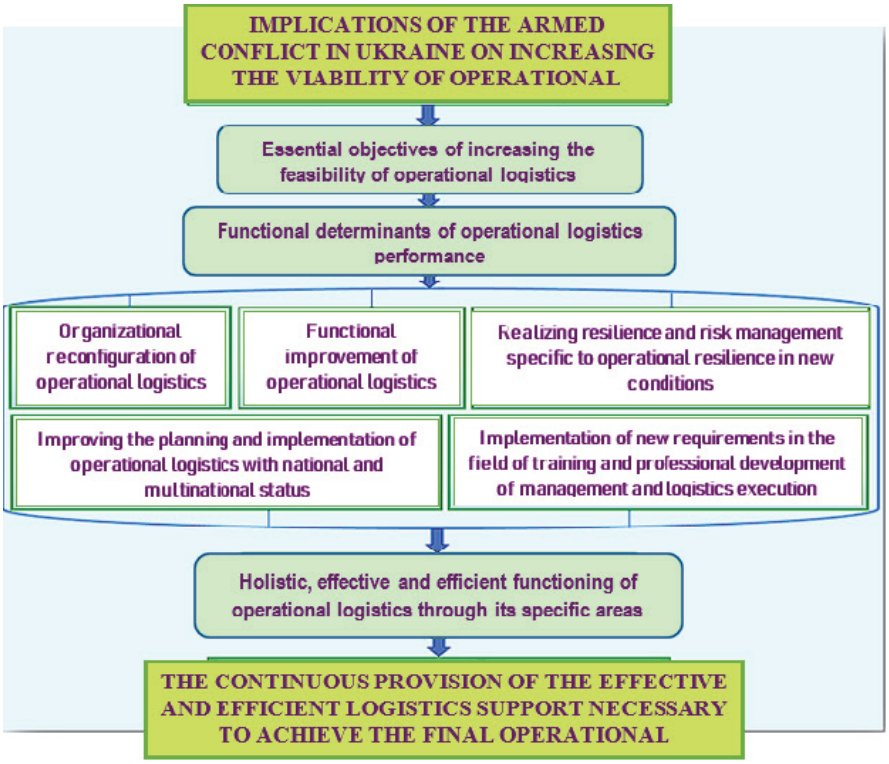

Fig. 3 Functional determinations regarding the increase of operational logistics performance [9]

The transformations and challenges determined by rapid technological and informational developments, specific to modern warfare, determine more and more conceptual and practical innovations for the continuous adaptation and modernization of operational logistics at all levels of military art (strategic, joint, and tactical), for achieving the overlap of the logistical support effort over the operational one to achieve success in the confrontation with the opposing forces and reach the final state in the area (theater) of joint operations in which national and/or multinational action and support forces are engaged. Therefore, the effect of increasing operational logistics performance is given, according to our assessment, by the relationship [9]:

$$E_{OLi} = (OLM \times OLn/Lon) - MR_fC,$$

where:

E_{OLi} = the effect of increasing operational logistics performance, expressed in value;

OLM = the mission of operational logistics, represented and expressed in value - given by total capabilities;

OLi = improving operational logistics (with increased resilience), with a determined value for total capabilities;

OLn = non-modernized operational logistics, with a determined value for total capabilities;

MR_fC = the consequences of the manifestation of risk factors, expressed in value.

The relational concretization of the aforementioned formula led us to highlight several objectives of maximum importance, according to Figure 3, which have the role of suggesting to specialists several ideas that can be exploited in the future for continuous modernization of operational logistics in the Romanian Army.

2.1. Organizational reconfiguration of logistics forces

Under the conditions of modern warfare, resulting from the confrontation between the aggressor and the defending forces in the joint theater of operations in Ukraine, there is a need for organizational reconfiguration of the logistics forces, especially at the tactical level, to increase their effectiveness and functional efficiency through improved structures, increased agility, resilience and robustness in the I, II, and III lines of operational logistics support. This requires structural and procedural improvement that allows ensuring a high level of sufficiency, flexibility, and modularity to ensure the optimal and timely provision of the resources and services necessary for the operational forces (at the tactical levels) și/sau joint), by the requirements, resources, the means, systems, and software available [10; 11], for the adequate fulfillment of the missions received and the achievement of the projected final state [12].

Regarding the structural organization, we consider that, at the level of the operational logistics modules (S4, G4, A4, N4, J4), organizational modeling is still necessary to increase functional performance to effectively manage, on a specialized basis, tactical logistic support units and subunits. To this end, for the logistic support execution structures, it is necessary, in addition to the appropriate transformation to achieve superior modularity and flexibility characteristics, to make and implement decisions to increase the level of protection by creating

and allocating additional structures intended for: defense against ground and air actions of enemy forces using modern high-precision strike means, including cyber disruption; operation of identification, jamming and countermeasure systems for all drones operated by the enemy for attack and destruction; use of drones intended for the transport of materials in limited quantities (up to 1000 kg. or more) [13; 14], especially for combat, support and/or special operations subunits and units [15] which act in isolated directions that impose constraints on the normal implementation of logistical transport operations; the use of tiny ("pocket") drones for the purpose of directing and monitoring the movement of transport columns with materials requested by combat and combat support structures, etc.

In terms of procedural organization, from our point of view, new abilities and responsibilities are needed from the bodies of management and execution of operational logistics support, which must act by the new requirements determined by the use of modern technology, high-performance weapons systems and, especially, in terms of planning and ensuring timely material consumption and the continuous implementation of adequate transport, maintenance, medical support, protection and self-protection operations against the destructive actions of adverse forces. In this regard, we consider that a pertinent analysis and evaluation of the functional responsibilities of the bodies of management and execution of operational logistics, as well as of the inter-functional relations between them (regarding the chain of command and horizontal and vertical communication flows) is necessary.

2.2. Functional improvement of operational logistics

The need for the continuous achievement of operational objectives by joint combat forces, in dynamic conditions characterized by uncertainty and increased risk, determines, from our point of view, an increase (overall) in the performance of operational logistics through the appropriate modernization of its functional areas. Thus, the first area - ***supply*** or ***resupply*** - requires the existence of advanced technical forces and means, which allow for the rapid receipt, reception, and distribution of materials necessary for the combat and support structures within the organic structure of a combat force (national and/or multinational) operationally integrated in the area of joint operations, which implies the existence of viable supply chains. To achieve the projected success in achieving the necessary logistical support for combat and support structures, the management of the advanced military supply chain has the role of achieving important objectives necessary for logistical concentration,

according to the operational effort, through: advanced, feasible, flexible and classified planning, which meets the requirements of resilience and risk management in the conduct of specific activities, for the delivery of the necessary logistical resources up to the fighter, equipment, fire system level [16], etc; the existence and employment of the forces, means and specialized infrastructure necessary for the rapid, efficient and resilient movement of goods between the components of the supply chain; the effective, protected, flexible and continuous implementation of distribution operations of equipment and other materials necessary for operational structures in any time, season and weather conditions ; the procurement and use of the RFID system based on GIS ("Geographic Information System"), necessary to increase the visibility of the movement of materials from the logistics support execution structures to military consumers and users (fighters, equipment, etc.) and for making real-time replenishment decisions [17].

In the perspective of 2035, the replenishment of the Alliance's operational forces focused on the on-demand (pull) process, will involve reducing the logistical footprint while ensuring timely and continuous provision at the tactical level (platoon, company, battalion, and similar) of all the resources necessary for the combatant forces to carry out their missions [18].

The existence of continuous flows of inputs and outputs of goods necessary to carry out planned operational combinations, in the integrated tactical operations areas of the joint (JOA), implies the existence of robust, versatile (lean and agile) supply chains [19], digitalized, flexible and resilient, allowing continuous flows (of information, goods, financial) [20] by integrating: *suppliers of goods; service providers; manufacturers; warehouses (belonging to existing logistics bases in the JOI); warehouses of economic operators (or belonging to branches of the body within the Alliance member state, specialized in the management and administration of state reserves); military warehouses (from the composition of the logistics support execution structures from the joint level up to, inclusively, the tactical level of the operational force); exoskeleton-type robotic devices to facilitate loading, unloading and handling operations in warehouses; consumers and end users (fighters, and equipment intended for the preparation and conduct of operations); civil and military transport entities; etc. We believe that each segment of the supply chain (mentioned) must be under the attention of responsible logistics commanders and managers, in terms of normal, effective and efficient functioning, corroborated*

with continuous protection from air strikes (with different means) and ground attacks (by surprise) by enemy forces.

In Figure 4, I highlight (in our conception, less the integrated image: Military) [21] a variant of a supply-delivery chain for the staggered distribution of ammunition, through military ammunition depots integrated into the logistic support lines (belonging to the profile structures) to the combatants and the equipment served by them, necessary to replenish stocks to prepare and conduct operations at the joint and tactical levels. The design and management appropriate to the effective and efficient functioning of the military supply chain management - M.S.C.M., so that the contracting and resupply with ammunition of caliber over 20 mm and up to 20 mm (Battle Decisive Munitions - BDM and NON-BDM) of the national combatant structures, as well as of the allied ones participating in the joint operation conducted on the national territory or outside it, is the responsibility of the J4/GFI and JLSG/GFI logistic module. During the implementation of specific MSCM activities, for the resilient and timely support of troops with sufficient quantities of ammunition, the leadership and execution structures of logistical support will also be involved (upon order) in a staggered manner, down to the lower tactical level (battalion or similar).

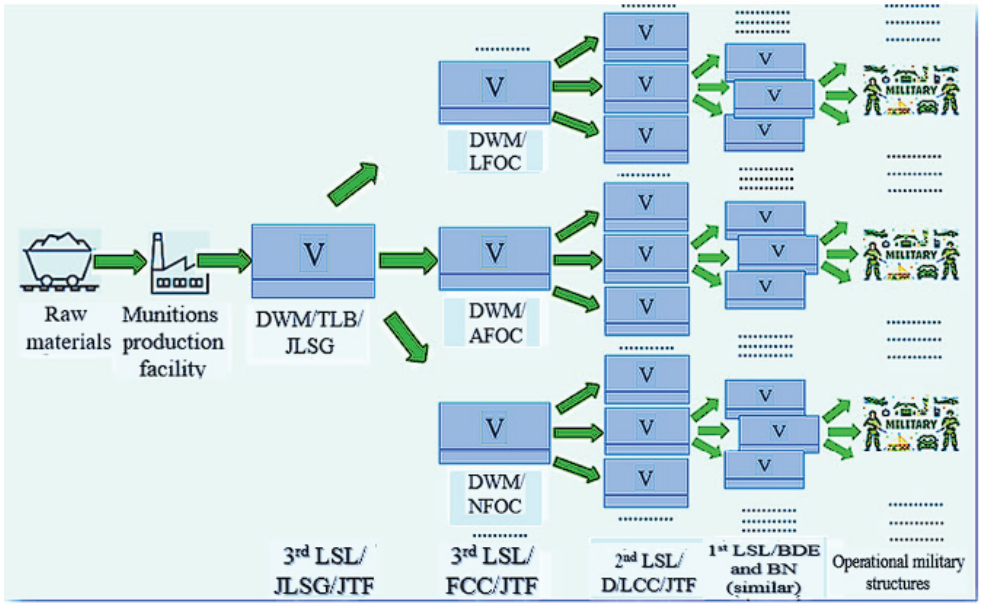

Fig. 4 Supply chain picture for supporting operational forces with munitions

Legend:

DWM/TLB/JLSG = Depot of Weapons and Munitions/Theater Logistics Base/Joint
Logistic Support Group;
DWM/LFOC = Depot of Weapons and Munitions/Land Forces Operational Command;
DWM/AFOC= Depot of Weapons and Munitions/Aer Forces Operational Command;
DWM/NFOC = Depot of Weapons and Munitions/Naval Forces Operational Command/;
3rd LSL/JLSG/JTF = 3rd Logistics Support Line/Joint Logistics Support Group/Joint Task Force (Corp level);
3rdLSL/FCC/JLSG/JTF = 3rd Logistics Support Line/Forces Components Commands/Joint Task Force (Corp level);
2nd LSL/D/LCC/JTF = 2nd Logistics Support Line/Division/Land Component Command/Joint Task Force
1st LSL/BDE and BN (similar) = 1st Logistics Support Line/Brigade and Battalion (similar).

To easily access real-time information and make appropriate decisions regarding acquisitions, requisitions, timely resupply, and/or timely provision of campaign services required by operational structures to properly fulfill the missions received, military logisticians (leadership and execution) can use rugged tablets. Entering the necessary data into the system of each tablet requires: either the use of several methods, including drones, 3D RealSense cameras, RFID scanners, and barcode readers; or their direct entry by user personnel [22].

The complexity of the destructive actions manifested in the theater of operations in Ukraine highlights lessons identified regarding the need for the survival of combat forces through planning and orders implemented by the command and execution structures of tactical-level operational logistics, which mainly aim to: establish the tasks of dispersing ammunition stocks necessary for conducting defensive and offensive tactical operations; identify possibilities for establishing places for performing maintenance operations on equipment that has become non-functional; continuous reconfiguration of command and control processes of essential logistical operations of supply, movement, transport, maintenance, medical support, for their

effectiveness and efficiency [23].

At the same time, the conduct of high-intensity operations on the Ukrainian front reveals another lesson identified regarding the consumption rates of ammunition and spare parts, which are particularly high. This implies the development of the industrial infrastructure necessary for the sufficient production of the aforementioned materials, to ensure the normal functioning of the equipment (armored vehicles, motor vehicles, fire systems, etc.) and the necessary resilience both in the initial stages of the defensive operations against the enemy's offensive invasion actions and during their other phases [23].

Given Russia's clear intentions to annex its eastern neighbor, combined with the significant shortage of equipment and ammunition intended for the defense of sovereignty by the invaded Ukraine, at the beginning of March 2022, a multinational aid body was installed within the headquarters of the US European Command. It had and aims to ensure that the resources of each donor state (equipment of all types, ammunition, and other materials, which have been and will be worth billions of dollars) reach the Ukrainian state army, as the beneficiary, to successfully carry out operations to liberate the entire national territory [24].

To respond to Russian attacks in the occupied areas and gain the initiative to launch the offensive necessary to liberate the national territory, the Ukrainian combat forces consume large quantities of ammunition daily and as such have a significant deficit of projectiles necessary for the operation of artillery weapons. Under these conditions, at the NATO level, it was agreed to increase the production of ammunition by the allied countries to that level that would allow the rhythmic supply of the Ukrainian state army [25].

If from the very first days of the invasion of Ukraine until today, the logistics of the Russian attacking forces have revealed continuous failures, the Ukrainian army, benefiting from direct support with equipment and other stringent materials by the USA and a host of other NATO member and non-member states, has managed to increase its mobility, protection and, as such, successes on the battlefield. Since October 2022, the Ukrainian logistics and engineering structures have benefited from the aforementioned states with adequate equipment for the identification, elimination and crossing of fortified areas (reinforced with dense obstacles) by the Russian invading forces, to repel or limit the counteroffensives of the Ukrainian army. To this end, the defense structures of the invaded state requested and received "demolition munitions, obstacle destruction and

remote demining equipment using detonating cord, mobile assault bridges, river and coastal patrol vessels, mine-resistant and ambush-protected armored vehicles (MRAP), as well as artillery-launched anti-tank mines" (according to the lists published by the Pentagon's authorized body for providing the necessary military assistance to Ukraine) [26].

At the same time, since February 2022, in addition to tanks, infantry fighting vehicles, armored personnel carriers, HIMARS, and precision ammunition, the US has also supplied the operational defense structures of Ukraine with: tactical towing vehicles; tactical vehicles for the evacuation of battle-damaged equipment (TEHEVAC); ammunition support vehicles; mobile assault bridge systems with Bradley support vehicles; trucks and trailers for transporting heavy equipment; logistics support vehicles; heavy tankers and fuel trailers; MRAP vehicles; armored utility trucks; mine clearance equipment; coastal and river patrol boats; C-4 explosives; demolition munitions and demolition equipment for overcoming obstacles; equipment for placing obstacles, etc. [26].

As part of the same joint effort to aid the Ukrainian army, the United Kingdom provided minefield clearance capabilities and mobile assault bridges. Germany, Canada, Finland, Slovakia, and Norway provided equipment such as engineering vehicles on Leopard chassis and the Netherlands provided mobile assault bridges and trucks [26].

- *Movement and transport* represent another operational logistics area that must allow both the planned deployment of tactical forces (national and multinational) in the JOA according to the increased requirements of military mobility in conditions of risk and uncertainty [27; 9], as well as continuous flows of materials (through transport) in the tactical field, for the immediate completion of the deficits resulting from consumption and/or destruction caused by the enemy. Regarding ⁎*transport,* in order to achieve the interoperability requirements, it is necessary to plan and carry out with appropriate means specific multimodal transport operations at the joint level, with an emphasis on the tactical level. In this context, very important (to be implemented) are the evolved processes of palletization and containerization by the provisions of NATO standards (in the field). This allows, for example, at the tactical level (within the framework of the land transport mode) a rapid transshipment of materials (packed in containers and/or pallets), as follows: *from railway transport vehicles to road transport vehicles; from road transport vehicles to*

tracked armored transport vehicles (especially in mountainous forested terrain); from tracked armored vehicles on carriers (up to the firing positions of fighters, armored vehicles, and fire means/systems). All of the above could be beneficially realized if, in our opinion, objectives were proposed and achieved, such as: continuous monitoring of (modern) motor transport vehicles by procuring and equipping them with advanced technical systems, intended to determine the visibility in traffic at any time (including at night) of both the means and the quantities moved (by transport); the acquisition of evaluated vehicles (automated, robotic and equipped with artificial intelligence), which can be directed through stations in tactical transport networks, without pilots (mechanics; the acquisition and use of armored tracked vehicles (usable with or without driver mechanics) necessary for the transport of materials to the combat supply points of (similar) combat and/or combat support companies; advanced protection (against attacks: ground of any nature; anti-aircraft including against drones; with CBRN means; of an electronic and/or cyber nature) [27; 9] *, sufficient and continuous support of transport structures and columns during the fulfillment of resupply missions both day and night,* etc.

The successes of the Ukrainian army in liberating the areas of the country occupied by the Russian invading forces were based on the continuous, effective, efficient, flexible, and resilient functioning of its logistics. To this end, on the territory of the Ukrainian state, there was and is a solid railway infrastructure of vital importance, with multiple branches from the railway junctions, which, regardless of damage, could be quickly reconfigured to carry out logistical transports, with the necessary transshipments on secondary routes, for the timely delivery of equipment and materials to the fighters. At the same time, the logistical structures of the Ukrainian combat forces have benefited and continue to benefit from a substantial contribution from civilian transport companies, as well as from assistance services in other areas of operational logistical support [28].

The need for rapid, timely, and on-site transport of materials, according to tactical and/or joint operational forces, has led to the increasing use of drones to provide logistical support to combat forces. In response to evolving operational requirements, since 1999, Lockheed Martin and Kaman Aerospace Corporation have developed the Kaman K MAX Unmanned Autonomous System (UAS), by adapting the Kaman K 1200 helicopter. Subsequently, after

a decade of research, testing, and contract development with the Marine Corps, two Kaman K MAX models were delivered to support operational forces in Afghanistan. Later, from December 2011 to May 2012, these UAS (existing within a detachment, which operated until 2014) were used to move (in the aforementioned theater of operations) significant quantities of materials from the main operating bases to the advanced ones. A study on the UAS profile conducted in 2013 highlighted its usefulness and efficiency, as well as its fundamental role in reducing the loss of human lives during combat and logistical operations. In October 2016, at the Marine Corps level, two structures (in collaboration), namely the Marine Corps Warfighting Lab (MCWL) and the Marine Corps Installations and Logistics - I&L), organized and conducted a war game, to test and implement specific engagement and operating concepts for three recently developed ULS models ("Unmanned Logistics System" ULS), according to a scenario that included a maritime expeditionary force and the appropriate logistical support to support its missions. The final report of the aforementioned war game showed that ULS is particularly effective in carrying out emergency supplies (considering the easy loading, unloading, maintenance, and "Just in Time" transport operations) in a high-risk operational environment (due to enemy actions), generating a reduction in the use of land convoys, but also of manned air transport. At the same time, it was concluded that it is necessary to continue research on ULSs to develop their technological and functional evolution concomitantly with the use of manufactured models [28; 9].

The previously presented facilities in the use of drones in the field of operational logistics are materialized by the Israeli Self-Defense Forces, which already have the bulky drone "Heron TP" (manufactured by the Israeli state company "Israel Aerospace Industries Ltd") with the effective capacity to transport a ton of ammunition [29]. On the other hand, in the UK, the delivery of logistical loads in hazardous environments, appropriate to the operational environment of combat forces, has become an achievable objective through the Autonomous Last Mile Resupply (ALMRS) project through which the "In View UAV" model was developed. This is an unmanned aircraft made of composite materials (with: two engines; dry weight under 20 kg.; wingspan of 5 m; minimum transport capacity worth 1200 dollars and maximum of up to 1000 kg.), with facilities suitable for vertical take-off and landing in rugged terrain [30; 9].

Within the tactical and/or joint operations of the future, the performance of operational logistics in achieving the profile support of combat forces with significantly reduced human losses, at the right times and in the right places, is dependent not only on ULSs, but also on a set of unmanned ground vehicles (drones) (Unmanned Ground Vehicles UGV), which can operate unarmed and in logistical transport missions, whose evolution is similar to that of UAVs, and their use is done in tandem with them [31]. Several years ago, the Estonian army tested (and later implemented) the unmanned ground vehicle "THEMIS" (a tracked infantry technical system with a modular design and robust components, produced according to the utility of choice in: armed version for combat; unarmed model for transport) through the "Milrem" company in a simulated operational exercise (three days), to carry out logistical missions of transporting equipment and materials [32; 33; 34]. The aforementioned model has been operational during several experimental exercises, as well as in counter-insurgency missions, such as Operation "Barkhane" in Mali. Therefore, for their operational and logistical facilities, THEMIS UGVs have been purchased by 16 countries, 8 of which are NATO members (i.e., Estonia, France, Germany, the Netherlands, Norway, Spain, the United Kingdom and the United States) [35; 9]. As I have already mentioned, these means are based on modern technologies and act complementary to robots and artificial intelligence, according to the objectives and logistical activities planned and programmed to be carried out in managing stocks and transporting materials to the combat structures [36].

Figure 5 shows a logistical mode of action of a maritime expeditionary unit supported by ULSs. The (logistic) support is initiated from the seashore (from the sea), developing inland to various maritime structures through several logistic platforms [37, 9].

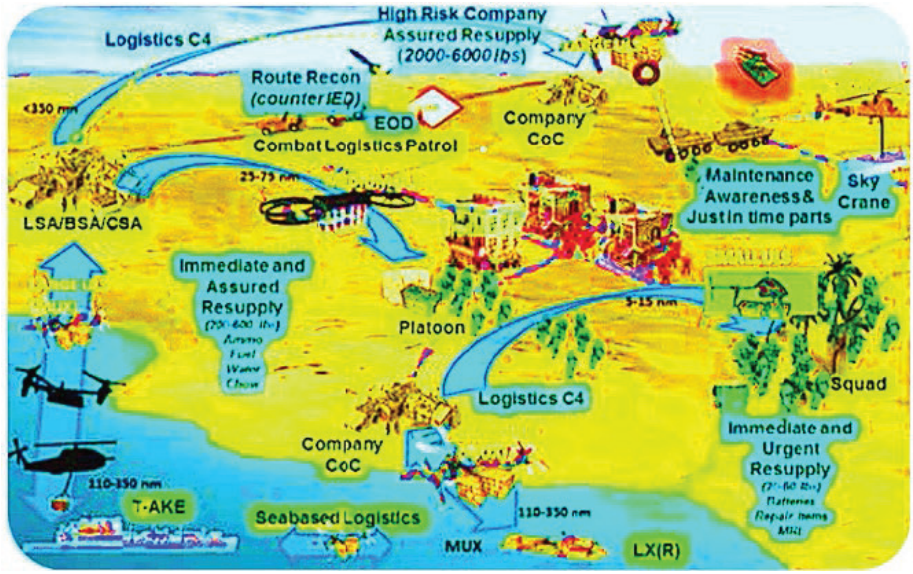

Fig. 5 Logistic drones (air and ground) are used to provide operational logistical support to a naval expeditionary structure (marine infantry) [37]

On 23.02.2023, the "Unmanned Systems Forum. Smart Approach, Fast Development" Forum took place, which was also attended by the Romanian Minister of Defense. There, new technologies were addressed, which will allow unmanned systems (through the development of multi-role capabilities) to have superior functional autonomy in modern warfare, focused mainly on those combat actions (with logistical implications and facilities) specific to reconnaissance, surveillance, target detection, electronic warfare, as well as for missions related to the protection of civilians or the precise identification of combatant and non-combatant structures [38].

For rapid monitoring of the transport and movement of materials (by supply class) intended for combat forces, in accordance with their requirements, both logistics managers and subordinate logisticians can use military tablets of the "rugged tablets" type, which include advanced security features (for example, CAC readers, i.e. "Common Access Card Reader") [39]. These contemporary operational resources can be deployed in command post facilities or directly in tactical environments, under severe and constraining working conditions. They incorporate appropriate durability requirements through design and manufacturing specifications and consequently necessitate only basic maintenance procedures, while simultaneously offering portability, lightweight construction, and ease of transportation during operational relocation. [40].

* *Movement* (as a subdomain of *movement and transport*) is the basis for the planned deployment of the operational force in the area or theater of operations combined with appropriate means (by moving: on national territory; strategic; at the operational or joint level) and includes the specific process of Reception, Staging, Onward Movement and Integration (RSOM&I) - as an important segment of operational logistics support [41]. The RSOM system is implemented as the 3rd line of logistic support of the joint multinational operation, which is prepared and carried out on the national territory or in an external theater of operations. Here, there are and operate, under protection conditions, a series of specific modern infrastructures, such as the air embarkation base (Aerial Port of Embarkation - APOE), the seaport port of embarkation (Seaport Port of Embarkation – SPOE), the rail port of embarkation (Rail Port of Embarkation - RPOE) - existing on the national territory in the area (territory) where the embarkation or embarkation of forces and means is carried out; Aerial Port of Debarkation (APOD), Seaport Port of Debarkation (SPOD), Rail Port of Debarkation (RPOD) - in the area (theater) of joint operations, where the forces necessary to be operationally engaged have been deployed; Holding Area (HA); Staging Area (SA); other elements [41;42]. A more complete picture of the RSOM&I mechanism, applicable by the US joint force in multi-domain operations, is presented in Figure 6.

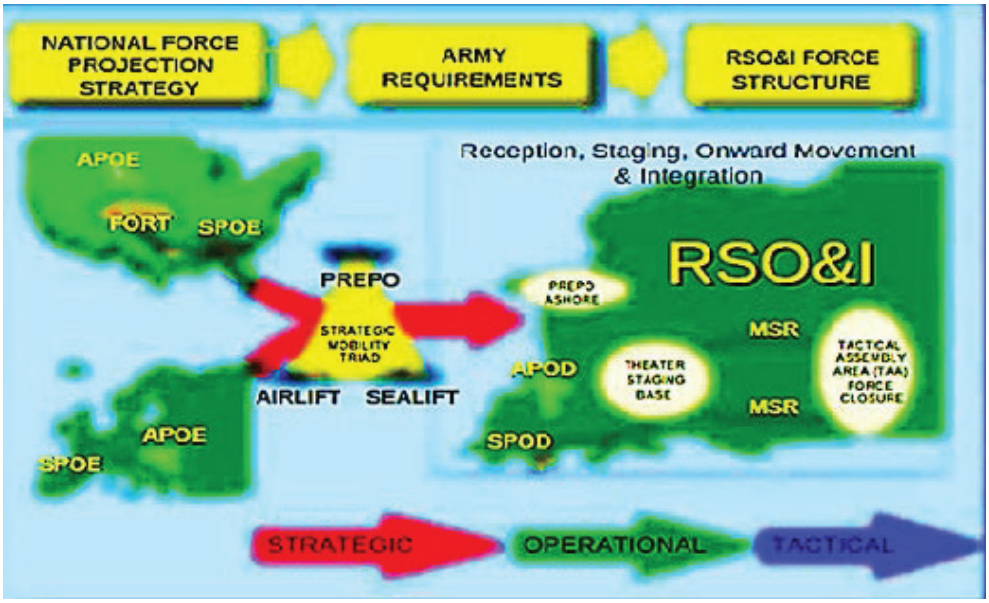

Fig. 6 RSO&I mechanism applicable by US joint forces [43; 44]

According to the requirements and exigencies of the specific mission, the Joint Logistic Support Group (JLSG), as an essential structure within the composition of the Joint Force, is directly involved and responsible for leading the deployment, support, and redeployment of operational forces in the area or theater of operations by accumulating and distributing the necessary logistical resources both with its forces and means and by carrying out operations specific to contracting and supporting the host nation (Host Nation Support - HNS) [45]. Therefore, the JLSG is responsible for the effective, efficient, and resilient organization and functioning of the RSOM in the area or theater of joint operations, which has specialized structures in its organization to support the combatant structures (of the operational commands: land; air; maritime; special operations, according to Figure 7) that act at this level [46], coordinating for this purpose - through its command and control authority (C2) - with the national support elements (NSEs) of the Alliance states participating with troops in the joint operation on national territory, with those responsible for the host nation's capabilities (operational request), as well as with contractors hired to provide materials and services by the requirements of the multinational combat forces [47].

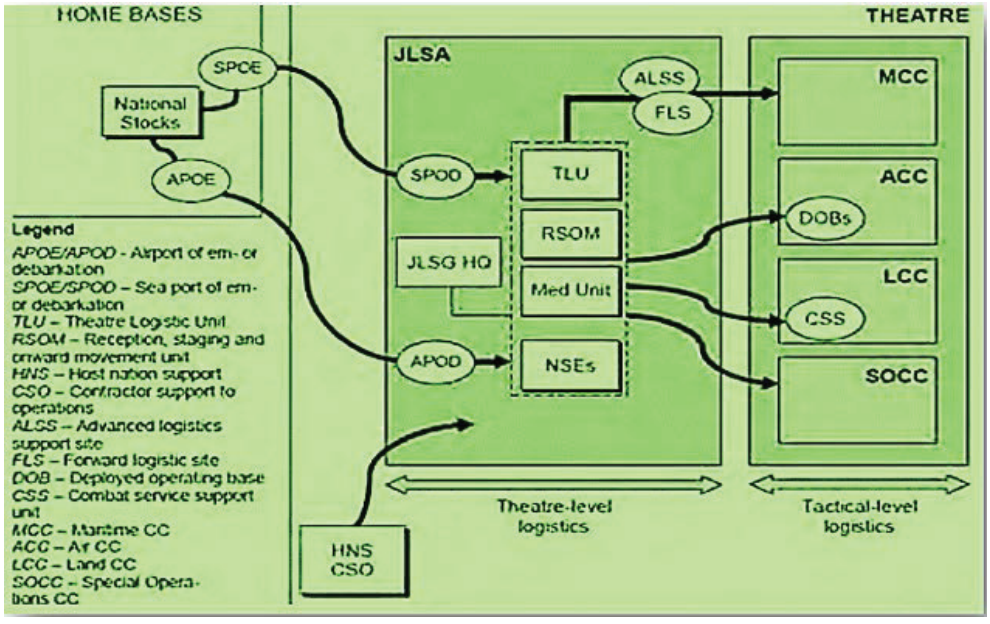

Fig. 7 Elements of the Joint Logistics Responsibility Area with JLSG and related functional relationships [47]

Given the lessons learned from the logistical failures of the Russian invading forces in Ukraine, we consider that, for the normal functioning of the RSOM mechanism in order to prepare and conduct a multinational operation assembled on the national territory, the following aspects could be taken into account: judicious planning of the activities specific to the 3rd line of logistical support by J4/JFC (Joint Force Command) and JLSG HQ (coordinated by J4) responsible for providing sufficient, flexible and resilient logistical support, according to the requirements received from the tactical operational forces (through their logistical management bodies) in the 2nd line of logistical support; the organization, coordination, command and control of the structures and facilities in the composition by JLSG HQ, for the effective, efficient and protected functioning of the RSOM; establishing viable, protected transport routes (Main Transport Route – MSR) with possibilities for variations in critical situations, which allow the safe movement of operational forces in order to integrate within the LRA (Logistics Responsability Area) within the tactical and/or joint device (according to the specifications in the OPORD received from the higher echelon); adequate replenishment of materials consumed from existing stocks at the combatant structures, during the movement (land, air, naval) in the area (theater) of joint operations, within the staging area (Staging Area); provision of additional quantities of materials (subsistence, ammunition, fuels-lubricants) for the combatant structures (combat and support) in the first echelon; other elements.

For the effective and continuous operation of the existing equipment in the combat structures, engaged in tactical and/or joint-level operations, it is necessary to improve the effective and efficient operation of the third important area of operational logistics, namely ***maintenance***. Very important here are the activities of planning and execution of maintenance activities in the preparation, conduct, and achievement of the final state of the operation concerning maintenance, evacuations, repairs, overhauls, and replacements of both combat vehicles and weapons systems. Particularly important here are maintenance materials, spare parts, aggregates, etc., which can be ensured through continuous resupply flows through single or combined push or pull processes, including through additive manufacturing ("Additive Manufacturing") of parts and components in the area of operations using printers 3D [48], 4D și 5D [49] or 6D [50].

Therefore, both combat vehicles (armored vehicles, trucks, etc.) and weapons systems (with increased performance) benefit (according to the requirements of opportunity and effectiveness) from simple or complex

maintenance works involving fighters, crew chiefs, drivers, maintenance teams, management, and maintenance execution structures at the tactical and joint levels. The functional unavailability of some modern equipment (combat vehicles and weapons systems) may determine the taking of operational limitation decisions for some tactical combat structures, due to the non-existence of the guarantee of timely maintenance interventions (a fact also observed during the armed conflict in Ukraine). In this regard, experts believe that, in addition to the intervention of trained military personnel (who service combat equipment and technical systems) in carrying out repairs of reduced complexity, the modular structures of modern combat equipment could facilitate (allow) replacement of major components (modules), thus eliminating important maintenance work, which would involve the movement and continuous activity of specialized teams and equipment (with adequate protection), as well as the occurrence of immobilizations and blockages [51]. Figure 8 represents a process specific to *tactical-level maintenance intervention*.

The skills of logistics managers, the existence of specialists, and easy technical means of intervention at their disposal will allow the timely planning and execution of activities appropriate to the maintenance and repair of military or civilian equipment necessary for the conduct of operations in the tactical field. In carrying out these activities, advanced technology is needed, such as rugged tablets, which help to accurately capture data and increase the efficiency of operations. These tools (means) can help military and civilian specialists included in tactical maintenance structures and organized in teams, to: carry out preventive or corrective maintenance operations on time according to requirements; timely repair vehicles; management of spare parts and consumables; track, monitor, and report the performance of all actions regarding maintenance, repairs, and provision of consumables; carrying out related tasks assigned to those listed [53].

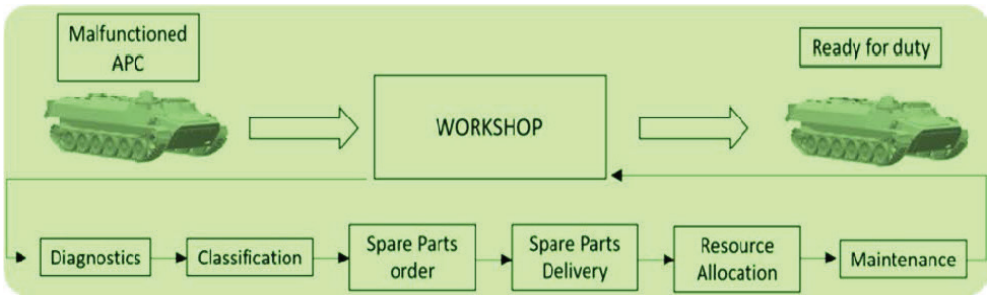

Fig. 8 Generic vision on maintenance intervention to a combat tactical structure [52]

The skills of logistics managers, the existence of specialists, and easy technical means of intervention at their disposal will allow the timely planning and execution of activities appropriate to the maintenance and repair of military or civilian equipment necessary for the conduct of operations in the tactical field. In carrying out these activities, advanced technology is needed, such as rugged tablets, which help to accurately capture data and increase the efficiency of operations. These tools (means) can help military and civilian specialists included in tactical maintenance structures and organized in teams, to: carry out preventive or corrective maintenance operations on time according to requirements; timely repair vehicles; management of spare parts and consumables; track, monitor, and reporting the performance of all actions regarding maintenance, repairs, and provision of consumables; carrying out related tasks assigned to those listed [54; 55]. A facility for protecting the performance of maintenance activities through the appropriate structures (from the joint level to the last tactical level) would represent a procurement of armored means for equipping maintenance formations to reduce human losses (primarily), during the conduct of tactical operations.

Another area of major importance in the planning and conduct of logistical support of tactical combat actions is ●*operational medical support*. The normal functionality, through the effective conduct of all specific operations (at the tactical and joint levels), is determined by its direct leadership and execution by the chief physician and the subordinate medical treatment formations (from MTF ROL 1 to MTF ROL 3) [56]. The operational medical support missions are carried out by the specialized structures of the joint force through specific "MEDEVAC" operations. These must allow tactical medical evacuations (also called "TACEVAC"), for the adequate transport of the wounded from MTF ROL 2 (from the combatant structures) to MTF ROL 3 (from the JLSG). From here, depending on the complexity of the interventions to be made, the strategic medical evacuation (also called "STRATEVAC") takes place from MTF ROL 3 at the joint level to MTF ROL 4 - located on the national territory or of another NATO state (depending on the situation, conditions, and urgency of the intervention) [41; 57; 9]. In Figure 9 we present the successive phases of medical evacuation, of the "MEDEVAC" type, from the tactical to the strategic level.

Given the current independent functioning at the tactical level of medical support compared to the areas of operational logistics [41] (following the practical reality in

the Romanian Army), we consider that this will lead, to the situation of real tactical operations, to the emergence of syncopes regarding: the correlation of logistical supply flows (appropriate to the other areas of logistical support) with those related to medical support; collaboration in planning and executing logistical and medical transports and evacuations; coordination of actions specific to the deployment on the ground (within the logistical support lines) of the logistical and medical support execution structures (given that the tactical planners are different), etc. However, for functioning within the required parameters, we consider that the tactical and/or joint leaders (commanders) must pursue the achievement of adequate and continuous collaboration both between the logistical and medical support management bodies, as well as between their execution structures during the preparation and conduct of joint operations. We also consider that, at a tactical and/or joint level, it would be important to: acquire armored means – including drones – for evacuating the wounded (from established points), which would allow for greater protection against attacks by enemy forces; protection against the enemy's destructive actions with ground and air means, especially with kamikaze drones [59].

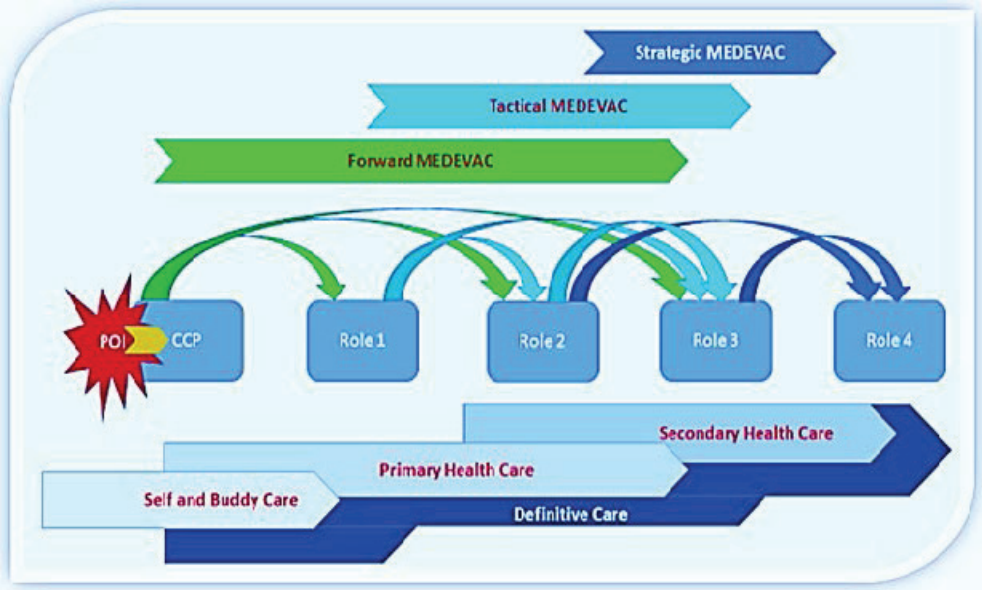

Fig. 9 Medical evacuation process within the NATO joint force [56]

The other areas (basic and related) of operational logistic support also require increased attention for modernization, taking into account the requirements and exigencies determined by the new military actions and challenges in the Ukrainian theater. In this regard, we would point out only one important requirement (related to campaign services), namely the acquisition of food preparation modules, which include mobile campaign kitchens and other technologically advanced food materials to replace the existing ones, to avoid deficiencies that appear during tactical exercises, due to the physical and moral wear and tear of the existing ones in the equipment of operational tactical structures.

2.3. Realizing resilience and risk management specific to operational logistics in new conditions

Providing logistical support according to the combat forces' operational situation requires the concretization of resilience and risk management specific to operational logistics in new conditions. This is based on analyses, assessments, and profile decisions, concretized in plans, orders, and documents, which will be implemented through activities appropriate to meet the identified organizational and individual requirements (consumption, use, and service provision) depending on the different capabilities that will be engaged and the established priorities. According to the operational context in the joint operations area, different logistical systems are integrated, within the combat devices of the combat and support forces, which must function effectively and efficiently without disruptions or turbulence. In this framework, the management and logistics execution bodies must act together to implement the necessary measures to increase the specific resilience of logistical support (provided to operational forces) in full correlation with the careful application of risk management at the tactical and joint levels [60].

Generically, the resilience of a military logistics system or a military supply chain (at tactical and/or joint level) represents the capacity to return to normal performance functionality within a favorable period, after it has been disrupted. At the same time, resilience reveals the capacity of the aforementioned systems to prepare to respond to the action of destabilizing impact factors (provocative of turbulence and uncertainty) that determine functional disruptions and interruptions (concerning the stopping of flows of goods and those adjacent to them, namely the flow of orders, the flow of production, the financial flow related to deliveries, etc.) to continue operations at an accepted level, as well as the levels

of connection and control over the component structures [61; 62; 63]. Figure 10 presents a graph of possible disruptions to an operational logistics system or military supply chain until it returns to normal functionality; it includes eight phases, as follows: preparation; occurrence of the disruptive event; first response intervention; production of the initial impact; manifestation of the total impact; carrying out recovery preparations; achieving recovery; manifestation of the long-term impact [64].

Several risk factors with an immediate effect on the disruption of the normal functioning of an operational logistics system or a related supply chain mainly refer to: the manifestation of terrorist actions; obvious turbulence at a supplier's factory (interruption of incoming flows of raw materials due to unforeseen causes; strikes, bankruptcy, fires, explosions, etc.); various natural disasters (earthquakes, floods, epidemics, etc.); major cyber-attacks, etc. [65; 66].

According to the international authorized body (North American CRO Council), it results that in business the concept of operational resilience is used, which highlights the capacity to carry out specific operations, even critical ones. The result, therefore, is the action of effective, efficient, and continuous management of operational risks, corroborated with the commitment of appropriate financial means to materialize the aforementioned concept of resilience through appropriate actions to prepare, adapt, resist turbulence, and impact, recover and eliminate functional interruptions of the given business system. Specific resilience planning within an economic organization reveals and involves activities specific to business continuity, in simultaneous or different phases, such as adequate response to the consequences of the incident; carrying out crisis management; recovery after impact; adequate implementation of intervention options specific to Cyber Security, third-party relationship management, IT, etc. [67].

Following what has been stated previously, it results that in the process of functioning of a logistics system or of the management of a military supply chain (MLAM) at the tactical and/or joint levels, phases of specific correlation of risk management with the resilience involved take place. Thus, the prevention of risks (through necessary actions for identification, early warning, and preparation of the appropriate response to any logistical crisis) determines the design and implementation of a mechanism focused on avoiding and/or reducing as much as possible the disruptions, irregularities and as such the vulnerabilities. The consequence

is the appropriate increase in the resilience of the logistics system or of the MLAM respectively based on proactive planning by phases and subphases of all specific actions, corroborated or common with those specific to risk management [77].

logistical crisis) determines the design and implementation of a mechanism focused on avoiding and/or reducing as much as possible the disruptions, irregularities and as such the vulnerabilities. The consequence is the appropriate increase in the

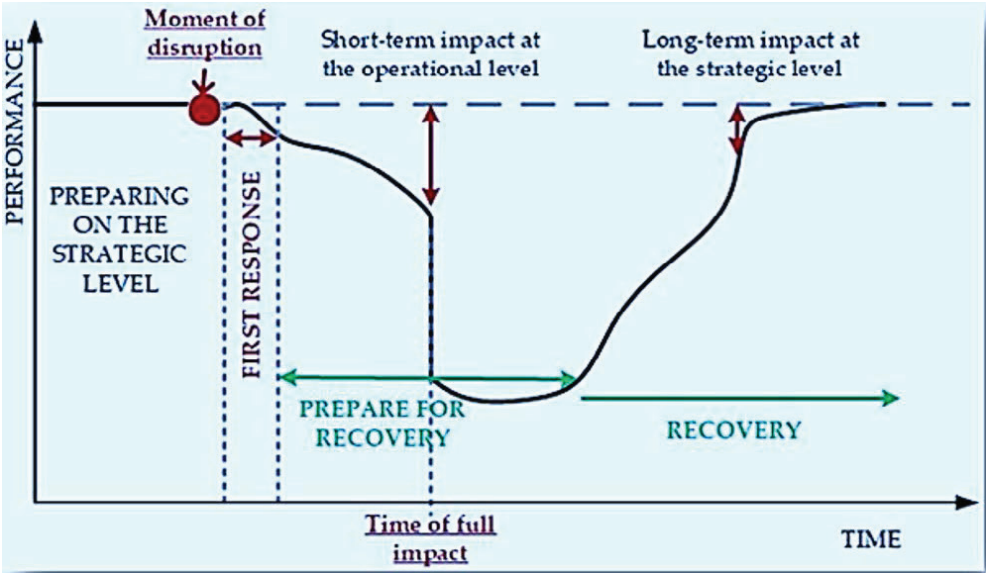

Fig. 10 Systemic vision on the resilience phases of an operational logistics system or related delivery supply chain [64]

By what has been stated previously, it results that in the process of functioning of a logistics system or of the management of a military supply chain (MLAM) at the tactical and/or joint levels, phases of specific correlation of risk management with the resilience involved takes place. Thus, the prevention of risks (through necessary actions for identification, early warning, and preparation of the appropriate response to any

resilience of the logistics system or of the MLAM respectively based on proactive planning by phases and subphases of all specific actions, corroborated or common with those specific to risk management) [68], continuity and functional protection; training of operational logistics management and execution personnel in the spirit of the appropriate applicability of both concepts, etc. Logistics managers and their

subordinates are responsible, from our point of view, for the effective and efficient planning and operation of military supply chains. These involve complex processes carried out by specialized personnel and modern equipment for the purpose of procuring, transporting, storing, and delivering materials by supply classes to the combatant structures of the operational forces, in a timely manner and at the indicated time, according to their requirements. At the same time, the aforementioned specialists must act collaboratively and cooperatively to create the safety conditions related to the movement and provision of the necessary resources to the military beneficiaries by adequately implementing risk management and resilience measures. Therefore, according to the experts' assessment, it is necessary for logisticians to periodically analyze the risks that generate disruptions and functional disorders within the operational logistics system and/or the related supply chain, in order to avoid and/or mitigate them in time. Within this framework, emergency intervention scenarios could be built depending on the types of operations carried out and the missions received by the operational forces (tactical and/or joint) based on decisions substantiated in advance, which would allow the full or partial implementation of the phases of the resilience mechanism (mentioned above), for the continuation of logistical support (by support areas) at a certain pace depending on the existing potential and augmented by the higher echelon.

The complexity of the operations of tactical and/or joint combat forces (up to and including the G.F.Î. level), as well as the logistical support related to them, obviously determines a different daily operational rhythm. If in this rapid mechanism of operational evolution insurmountable discrepancies appear between the dynamic action of the combat forces and the logistical support necessary to be given to them, a specific crisis phenomenon will soon manifest itself (partial or total deficit of logistical resources and services), known in the economic field as the logistics culmination") [64], considered by us, at the operational level, as a logistics critical point or logistics critical deficit. Here, effective manifestations of adequate resilience in supply, transport, maintenance (as areas of operational logistics support) and medical support can be evident, because the avoidance of the manifestation of disruptive (risk) factors can no longer be prevented (at a given point) even though visible intervention measures have been taken (according to the requirements implied by the action effort) [69; 70] (Figure 11).

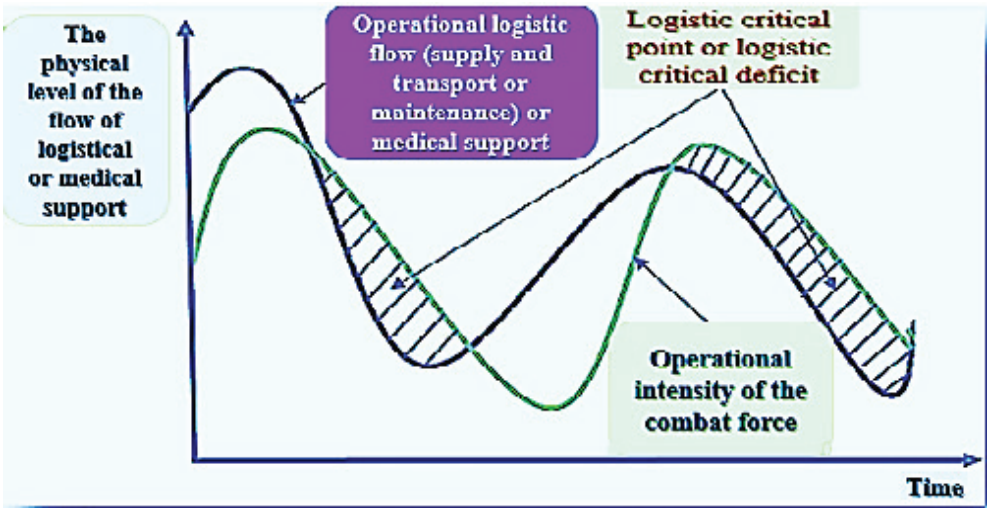

Fig. 11 A picture of the logistics critical point (deficit) [9]

In figure 12 we reveal the way in which the logistics critical point (deficit) manifests itself, which reveals a relationship and integration with the specific resilience graph presented previously. According to what has been revealed, we believe that it is possible to deduce the manifestation of the effect of possible risk-generating elements, such as: the insufficiency of logistical resources made available in the event of increased operational intensity, which would highlight the failure of logisticians to anticipate the situation in order to supplement the profile support; unpredictable actions of enemy forces on supply sources, transport columns or on logistic support subunits and units; ad hoc introduction of additional combat forces into the tactical and/or joint device, for the operational development necessary to reach the final state, not included in the logistical planning and execution processes, etc.

From our point of view, the critical logistical point (deficit) can appear during any tactical operation, with an immediate effect on the rapid decrease in the effectiveness and efficiency of the logistical support provided, taking into account the requirements highlighted below. For example, with the territorial (geographic) development of the area of operations, by the operational (tactical) forces conducting offensive operations, several requirements with increased risk (disruptive) potential appear in the provision (exhaustion) of the logistical resources necessary for resupply, such as: the increase in the need for material transport means (ammunition and lubricant fuels, in particular) for combat and support structures, to cover additional distances (under protection conditions); the need for

increased protection of components of military supply chains (suppliers, manufacturers, logistics bases, material depots, logistics structures within the combatant tactical organizations, etc.) from the destructive actions of enemy forces; requesting prompt intervention with logistical resources by the higher echelon in critical situations, to avoid the emergence of a critical logistical point (deficit), etc. [70]

Consider the situation in which the enemy strikes, for example, a mixed territorial material depot, after implementing all risk management actions, the destructive and disruptive impact can determine the progressive and total destruction of the stored quantity of a product (ST), according to Figure 12, including the safety stock (Ss) and the current stock (Scr). For some time, the stock is non-existent, there is a stock shortage, and as such the storage infrastructure must be quickly rebuilt and then daily replenishment activities must be scheduled and carried out - until the initial level of the total stock (ST) is effectively reconstituted, with the two parts mentioned.

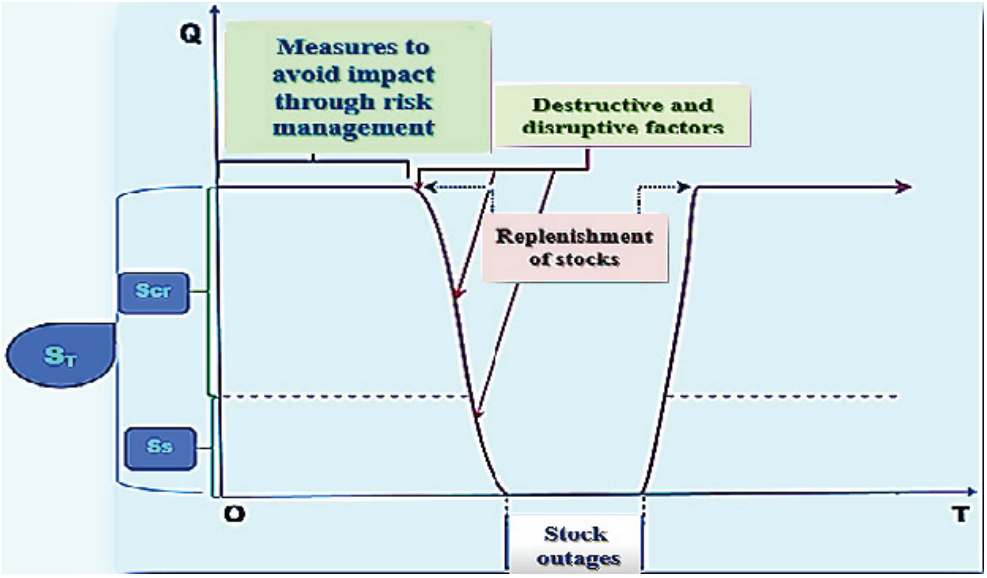

Fig. 12 Briefly identifying the specific phases of resilience related to a mixed territorial material repository [9]

Legend:
Q = The quantity of product "X" stored;
Ts = Storage time;
S_T = Total stock in warehouse;
Ss = Safety stock in the warehouse;
Scr = Current stock in warehouse.

If we consider the way to highlight the resilience of the stock of a material (from classes I, III, V) existing (on combat structures and in warehouses) at a tactical and/or joint echelon, here, the safety stock (Ss) represents the troop stock or the operational stock (i.e. the planned stock – Sp), and the current stock (Scr) includes the amount of Combat Day of Supply (CDOS), which would be consumed in a day of combat. Of course, depending on the situation, the troops can be resupplied with the required materials from the safety stock (i.e. Sp), with the deficits to be filled 100% in the evening of the day of operation, upon request, by the higher echelon.

Based on what is presented, both logistics managers and their subordinates in the logistics modules can use three indicators to determine the level of resilience of operational logistics support [83], as can be noted further on.

2.3. Improving the planning and implementation of operational logistics with national and multinational status

All of the above-mentioned imply the improvement of the planning and implementation of operational logistics with national and multinational status (further details are provided in Annex 6), which must involve systemic and subsystem improvement in the planning of operations of combat forces (in their preparation and conduct) at all levels of military art, a process that needs to be carried out rigorously by evaluating the forces, resources employed, risks and elements (indicators) of progress in the accomplishment of missions. Within this laborious mechanism, commanders, staff, and logistics managers (together with their subordinates) will skillfully lead complex processes, appropriate for the development of specific effective, resilient, and integrative planning (for immediate or future application), in action situations and correlated operational stages, such as current operations, focused on the adaptation (modeling) and immediate application (execution) of existing OPLANs (implemented through related OPORDs and sometimes modified/added through FRAGOs, with specific evaluations and feedback), which influences the plans and orders that will be issued in the future; future operations, involving newly established objectives, actions and priorities (by the specifics of the new missions received by the subordinate forces) and materialized in very well-founded and modeled plans and orders of operations along the way, to successfully achieve the final operational state [72; 73].

Figure 13 presents an overview of operational logistics planning at tactical and/or joint levels. All

elements in the figure are based on NATO specifications regarding the organization and conduct of this process (integrated into operational planning) in a national and multinational context, according to the level at which it is carried out, namely strategic, operational (joint), and tactical [72]. According to our approach, the macro component of operational logistics planning targets the entire mechanism specific to the tactical/or joint echelon at which it is carried out, integrating the micro side appropriate to the areas of logistical support to be provided to the respective combatant force.

Experience in the field reveals that, in the process of planning operational logistical support, integrated into

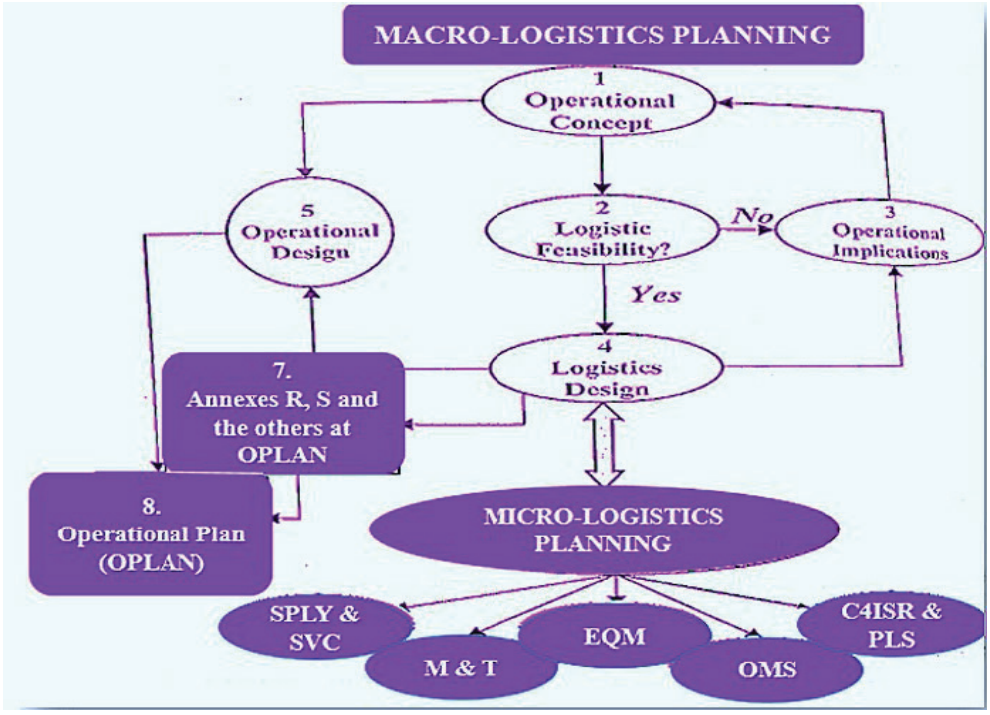

Fig. 13 The generic mechanism of operational logistics planning at tactical and/or joint level [9]

Legend:
SPLY & SVC = Supply and Services;
M & T = Movement and Transportation;
EQM = Equipment maintenance;
Operational Medical Support (OMS);
C4ISR & PLS = Command, Control, Communications, Computers, Intelligence, Surveillance and Reconnaissance (C4ISR) and Protection of the Logistics Structures (PLS).

the combat force mission planning mechanism, according to the analysis and evaluation of experts, the "Military Logistics Network Planning System" - MLNPS system can be used, through which, based on effectively simulated events, supply requests are processed according to the dynamic demands of fighters and equipment. This action will continue, so that following the interactive simulation and adjustment of the MLNPS network, the effective, appropriate, sufficient, and resilient logistics footprint can be identified in a short time, per the requirements resulting from the operational scenarios, staged [74].

Therefore, logistics planning in its known fields involves military logisticians who are perfected and experienced through proactive, anticipatory, and flexible thinking, vision, and action, who possess advanced capabilities for correlating and harmonizing the requirements for supporting operational forces with the availability and visibility of the resources that must be provided, depending on the particularities of the missions received, the specificity of the operational environment, the time available and the constraints that may arise as a result of the emergence and manifestation of risk and uncertainty factors. To this end, the judicious planning of operations specific to operational logistics requires a continuous exchange of adequate information (some even classified), necessary primarily for conducting transactions of goods and services between economic operators in the area of military actions and the beneficiary combatant structures [75].

The limitations that may arise, from our point of view, in planning the provision of the requested logistical support (during the preparation of the operation and/or during its conduct) are based on constraints concerning: the insufficiency of the resources necessary to fully cover the deficits reported by the tactical and/or joint-level operational structures, reduced sources of supply and/or service provision; significant losses predicted, as a result of the possibility of the enemy striking their own operational, incompletely protected logistical capabilities, etc. Under these conditions, the skill of logistics managers and subordinate specialists (logistics) consists in allocating the available resources by: the priorities of each operational force, according to the mission received; its place and role in the tactical and/or joint device; the deficits found, reported to the higher echelon and the sources (facilities) made available; the protection measures that must be implemented during supply-distribution operations (reception, transportation, storage, handling, delivery, specific information flows), etc.

Future functional development efforts in the face of an increasing

diversity of threats oblige command and execution logisticians to flexibly manage the capabilities available to adequately support operational forces engaged in defense and/or expeditionary operations. Plans and orders for the preparation and conduct of tactical and/or joint operations are based on the projection (planning) of the related logistical potential, which can undoubtedly impose certain action (operational) limits. However, here the skills of logistics managers would also come into play, who through proactive, anticipatory, creative, and adaptable actions could determine the supplementation of the facilities (capabilities) to support combat forces by using other military and civilian sources in the area of operations (established by the higher echelon or identified and exploited with its agreement). At the same time, logistics specialists could act complementary (implementing planning procedures and tools or suggesting future operational actions), to balance and adjust the sufficiency of resources, by: *using high-performance equipment and fire systems; accumulating and pre-positioning protected support stocks for tactical expeditionary structures; operational restructuring of forces or groups of tactical forces while maintaining operational objectives (by virtue of the strike potential given by modern weapons systems in the equipment), to reduce the volume of logistical support granted to them [76] (for example, in the French army, in the immediate future, there will be a partial reduction of tank and infantry regiments in favor of expanding those profiled in long-range artillery, cyber actions or the use of drones; delaying offensive and/or expeditionary operations (tactical and/or joint) until the effective and sufficient procurement and provision of the resources and logistical services necessary for achieving operational success by the combat forces engaged,* etc. [77]. In line with what has been presented, experts believe that in the planning processes at the tactical and/or joint levels, it is necessary to identify military and non-military structures (such as economic operators, suppliers of goods or service providers, etc.) that can be engaged in complementary logistical support activities for multi-domain operations, even in less accessible areas [78].

Operational experience demonstrates that, even when a commander's strategy and tactics are sound, adequate combatant force logistics systems can quickly degrade, becoming unavailable shortly after a major operation has begun. Common problems, such as the intensification of inadequate use of strategic, operational (joint), and tactical reserves, disruption of specific supply chains, and insufficient information management, can reduce operational

logistics availability by about 70% in the first 30 days of high-intensity armed conflict (as happened with the Russian invading forces in Ukraine) [79]. It follows, therefore, that proactive and anticipatory actions for planning logistical support, carried out by logistics management officers and their subordinates, by the (relevant) data and information received from the intelligence and operations structures (of tactical and/or joint commands) can determine in advance the augmentation of stocks and equipment in conditions of increased resilience so that the combatant structures benefit from an overwhelming operational advantage (with an even double combat potential) over the attacking forces of an adversary [80]. Figure 14 presents a variant of the gradual diminution of the operational logistical capabilities of one's own forces, as a result of enemy actions in a high-intensity conflict.

2.4. Implementation of new requirements in the field of training and professional development of logistics management and execution officers

The efficient functioning of operational logistics obviously requires the implementation of *new requirements both in the field of training and in the field of improving the training of officers who will perform leadership or execution duties of the necessary logistical support to combatant structures.* To this end, the lessons identified from the conduct of the armed conflict in Ukraine highlight the need for both the commanders of the combatant forces and the logistic personnel (leadership and execution under their command) to proceed with setting objectives, developing concepts and carrying out future actions to obtain organizational (logistical) performance by the missions received, especially in

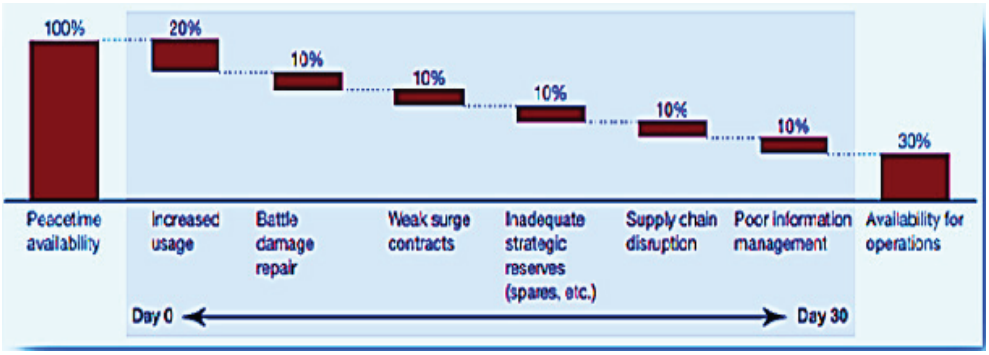

Fig. 14 A picture of the continuous diminution of the operational logistics potential of the (own) combat forces in a high-intensity conflict [80]

situations of crisis and armed conflict. For example, the essential elements of influence that have changed operational and logistical perceptions, as a result of the war waged on the territory of the Ukrainian state, are: *the intensive use of artificial intelligence; the predominance of air defense to the detriment of combat aviation (with invisible, reconnaissance surveillance aircraft, bombers, etc.); the establishment of stockpiles of materials sized at a higher level, due to increased operational requirements; the sharp development of the planning and conduct of operations (offensive and defensive) with combat and material transport drones (of various types; with the immediate prospect that drones for operational use will be programmed to select targets and act autonomously, without the intervention of operators); obtaining important data and information, adequate to the performance of missions (such as: maps, satellite photos, etc.) necessary for the geolocation of targets and the execution of reconnaissance (including logistics for the movement, disposition and resilient operation of logistical support structures) from open sources (Open source; OSINT) such as: internet; social networks; available Google applications; video clips; dialogue groups, etc.; decentralization of command of each combat and/or logistical support structure (noted beneficially in the Ukrainian defense forces, compared to the invading Russian ones)* [81].

Based on the above, we believe that a balanced combination of theory and logistics practice is necessary, according to the new requirements, taking into account (especially) the mistakes and deficiencies manifested in the Ukrainian theater of operations. From this, important lessons emerge, which must be implemented in the logistics educational process to train and develop the skills necessary for future logistics officers to understand and apply everything that logistical support to operational forces (at the tactical and/or joint levels) represents and will mean, engaged in complex (future) armed confrontations. All of these are based on the projection of the soldier of the future, correlated with the rapid progress of the modernization (primarily) of combat equipment and ammunition (which include unimaginable technological developments in the fields of automation, robotization, digitalization, and artificial intelligence), considered as determinants of the continuous transformation and change of methods and procedures of action, specific to operations carried out at all levels of military art (strategic, joint and tactical). Therefore, in these conditions, the advanced and continuous training of military logisticians (at all hierarchical levels) is very important, because the logistical support that will have to be

provided to operational forces (with national and/or multinational status) will involve adequate modernism and as such, new ways of thinking and managerial action and/or execution (collaborative and cooperative) will be necessary, involving high-performance capabilities (in terms of logistics), which must be effectively and efficiently used, as well as very well protected (during their operation) from complex and continuous attacks by enemy forces, so that the missions of the combatant structures can be accomplished whenever and wherever they act offensively or defensively.

It would be important that shortly, each tactical combat structure in the Romanian Army goes through, in our opinion, a professional development process that, like in the armies of some advanced Western NATO states (USA, Great Britain, France), includes several stages with activities specific to modernization, preparation, training and the fulfillment of operational missions (offensive and defensive). Such a process will require both operational aspects and related logistical support: *specialized military personnel (leadership and execution) with enhanced skills; high-performance equipment and weapons systems; automated, robotic, digitalized, and sufficiently protected means for transport, storage, camping, maintenance, medical support; advanced means and systems for protection against attacks of any kind, including cyber attacks, etc. Some of these resources exist, and others are to be acquired (through: training and education of human resources; acquisitions and/or modernization of technical and material resources; procurement of advanced systems for visibility and protection,* etc.).

3. CONCLUSIONS

Modern operational logistics is a continuous cyclical process, which is carried out from the moment of receiving the mission until the moment of making the decision and, thereafter, during combat actions until the cessation of all activities and even for a period thereafter, during the transition phase. The characteristics of conflicts and situations of instability highlight risks and threats of a military and economic nature with an impact on the infrastructure of the areas and/or theaters of operations and other implications, which requires the provision of adequate and timely logistical support for the successful accomplishment of the missions received by the combat forces engaged in tactical and/or multi-domain operations. In this context, it is easy to explain why it is necessary to use operational logistics management to achieve the optimal direction of logistical resources appropriate to achieving operational

objectives and the success of military actions. Logistics managers and their subordinates have extremely complex missions in the preparation and conduct of operations of the combat forces of the future.

Current changes, actions, and transformations in the military domain bring to light new challenges and dilemmas, involving ensuring an optimal balance between the need to have well-trained and modern troops, the significant number of missions, and increasingly limited resources. Thus, in the resulting situation, logistics stocks must be reduced, the quantities to be transported must be reduced, and the reaction time must be significantly shortened. Consequently, the transformation of military operational logistics is perceived not only as a central point in the future of logistical support but also as a lever for the effort of combat forces to ensure the appropriate balance between the state of readiness and their continuous functional modernization. The reaction of logistics decision-makers must respond to these challenges, which leads to the need to examine how military logistics transformation and decision-making can best respond to current circumstances and demands, dominated by the continuous adaptation of capabilities to new sustainability requirements.

In order to achieve their tactical operational goals of a logistical nature, the aforementioned specialists need solid training, competence, responsibility, a lot of initiative, and perseverance. Consequently, particularly important in the economy of military actions, shortly, is the reduction of the "volume" of operational logistics by reducing the duration of supply/ resupply flows appropriate to the areas and/or theaters of operations. This is relatively easy to define, but much more difficult to achieve. The greatest challenge for logisticians of the future will be to ensure a versatile, interactive logistics system, capable of effectively and efficiently supporting military operations, prepared and deployed in increasingly complex operating environments.

Therefore, the increase in operational logistics performance is and will be given by the magnitude of technological advances that will take place in the future, such as: *the realization of 3D 6D printing; the use of alternative energy sources; the use of robotic systems intended for the evacuation of the wounded; production-delivery of modern combat equipment, as well as of developed unmanned technical systems (air and ground) necessary for a tactical and/or joint force to increase the facilities related to resupply operations (of materials), maintenance, repairs and medical support. It follows, therefore, that*

the use of these technologies will determine the improvement of logistical functions, concomitantly with the reduction of risks in the processes of providing operational logistical support.

Under these conditions, it is obvious that the operational forces of the future will benefit, in addition to options for decentralizing tactical and/or joint maneuvers, from modularly organized, flexible and adequately protected tactical logistical entities (structures), which have transportation, storage, warehousing, maintenance facilities and apply effective, efficient and resilient logistical support procedures. To achieve these goals, very well-trained logistical leaders will be involved, who will plan and carry out advanced and complex logistical support operations, given the limited resources in the areas of operations within the theater of joint operations.

The transformation of operational logistics of combat forces will also depend in the future on: *logistics based on real-time distribution, considered to be the most important product of the revolution in the field of operational logistics; elimination of intermediate links in the supply chain, which will determine the creation of a flexible logistics system and the reduction of financial pressures, as well as other facilities (such as: elimination of excess stocks; a much faster response to the requirements of military beneficiaries; identification and application of the best solutions to reduce the impact of possible failures, before they occur); modernization of equipment, which involves their proactive monitoring and diagnosis, as well as adequate preparation of maintenance structures for interventions and evacuations*. Achieving these objectives requires rethinking logistics processes, organizational restructuring of the profile, development of new sensor systems and diagnostics of modern equipment, implementation of an advanced information, support, command and control system, but also the existence of very well-trained (logistics) personnel, capable of operating with the expected performance.

As stated, future operations imply that, at the tactical and/or joint level logistics systems, specific decisions regarding the allocation of limited resources should be based on the size of the requests, the availability of resources, the time available to execute effective and resilient support actions depending on the robustness of each existing and possibly augmented logistics organization. This implies optimal planning of the logistical support of future military operations to reduce risk and uncertainty as much as possible, which requires creativity,

organizational skills, and innovation on the part of the logistics personnel (management and execution) involved.

Current and future military challenges are causing state and Alliance decision-makers at various levels to place increasing emphasis on future national and multinational defense requirements. This requires highly trained operational military leaders and (subordinate) logistics managers with the skills necessary to adapt immediately to the evolving and changing needs of the future joint theater of operations. The logisticians of the future army will be the leaders of the command and execution structures of major importance on the battlefield. They must delegate, adapt, take risks, and invest energy and effort to accomplish the complex missions assigned to them. As heads of the J4, G4, A4, N4, S 4 logistics modules (or their components), as well as commanders (deputies or chiefs of staff) of the logistics support execution structures (from the joint to the lower tactical level), they must be experts in understanding, hierarchically transmitting the real logistical situation in the field, proceeding further to carry out the planning processes and providing the logistical support requested by the combat forces.

The further development and modernization of operational logistics, according to the new requirements revealed by the war of the future, will be able to allow the combat and support structures, at the tactical and joint levels, to become more prepared, mobile, flexible, effective and efficient under the objectives and requirements of the future missions received.

For a prospective analysis, it results that operational military logistics will be modernized by reconfiguring the integrated logistics systems of the combat forces at the tactical and joint levels, as a result of the evolution of equipment, information technology, and the functional optimization of combat and support structures, for a greater and more precise reaction capacity in any circumstances, according to the missions received within the framework of multinational operations carried out on national territory or outside it within and under the aegis of NATO.

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