# REDUCING THE LOGISTIC FOOTPRINT – A DESIDERATUM OF PAST AND FUTURE MILITARY OPERATIONS

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*With the technologizing and modernization of the armed forces, the emergence of fuel-consuming self-propelled means of transport and weapons systems of all ammunition-consuming gauges, the logistical challenges were not delayed, the logistics footprint grew, the support of military operations involving resources more diversified, more voluminous and requiring an increasingly systematic and integrated approach to the concept of the operation as a whole.*

*The logistics footprint in the military operation consists of the whole of the organizational entities, the resources managed by them and the activities carried out in order to achieve the logistic support of the fighting and the fighting support units so as to ensure the living conditions and the freedom of action necessary to achieve the objectives.*

**Keywords:** *logistic footprint; technical or procedural innovations; logistic resources.*

The logistic support of military actions has been, from ancient times, an essential decision-making element in the planning, organization and execution of operations. At the same time, the logistics structures and their activities represented and still represent a stone in the boots of the commanders; movement speed and lower mobility are just a few features that require caution and increased attention in carrying out armed conflict-specific activities with effects on configuration, time and space demarcation, supply chain and battle stocks management.

As a logistics officer, I have always wondered how the military campains over two millennia ago, such as Alexander the Great, the Persian or Roman Empire, were organized in terms of supporting the troops. The logistic support related to them was related to providing food (for humans and animals) and equipment, as well as to movement and transportion of forces. The efficiency of any logistics system as perceived today is limited, among other things, by the ability to communicate and transmit messages, orders and requests in a short time, and that capability could not be sufficiently developed given the distances at which the information had to be reached. That is why the campaigns were planned so that the forces engaged in the struggle would benefit as much as possible from the existing resources in the conquered territories, especially the food and water, avoiding the winter or unfavorable times and focusing on the intervals in which harvesting were carried out on agricultural crops. War pillages and catches were an important source of supply.

With the technologizing and modernization of the armed forces, the emergence of fuel-consuming self-propelled means of transport and weapons systems of all ammunition-consuming gauges, the logistic challenges were not delayed, the logistics footprint grew, the support of military operations involving resources more diversified, more voluminous and requiring an increasingly systematic and integrated approach to the concept of the operation as a whole.

Trying to understand the concept of logistic footprint in the military operation, we can say that it consists of all the organizational entities, the resources managed by them and the activities carried out for the logistic support of the fighting and fighting support units, so as to ensure the living conditions as well as the freedom of action necessary to achieve the objectives. The specifics of the operations conducted and the size of the force are the main factors that impose the dimensioning of the logistic footprint so that essential requirements of logistical support, such as the sufficiency and continuity of resource provision, flexibility and mobility of the logistic system, can be ensured by existing capabilities.

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And yet, given the increasing need of the past decades to limit resource consumption and make it more efficient to use it in all areas of everyday life, especially in the military area and armed conflicts, as well as the ever-increasing scale to which the current military operations take place, with the involvement of multinational coalitions, there is an arduous interest in reducing the logistic footprint in the theaters of operations, while ensuring a superior quality level of support for the operation. In other words, the current political and economic context requires achieving higher goals, using quantitatively reduced resources. We therefore discuss in terms of efficiency and effectiveness in logistics.

Analyzing from this point of view some of the armed conflicts of the last century and especially the logistic support associated with them, we could extract some attempts to reduce the logistics footprint through technical or procedural innovations, some even successful and able to decide the success of the operation or at least shorten the duration of the conflict and considerably reduce the costs and resources involved.

In the *Korean War* (1950-1953), US logistics relied mainly on material resources from the Second World War. Without their existence, this conflict in the Korean Peninsula probably would not have taken place or would have been conducted without the contribution of the United Nations or the United States[1]. However, the existence of much of the material resources did not generate the lack of logistic difficulties and challenges. These mostly occurred in the field of labor supply in the area of logistic responsibility, both in the peninsula and at the points of reloading of materials, especially in the logistics bases on the territory of Japan. In order to provide labor force requirements, the US would have to supplement the service staff involved in the conflict with several hundreds of thousands of people, from material manipulators to engineers and motor mechanics, which would have led to a significant increase in costs and would have generated another set of difficulties related to the deployment and self-sustaining of these categories of staff.

The solution to overcoming these difficulties was to identify and engage in addressing the administrative problems of the indigenous workforce. Only in Japan, in the absence of local employment to provide supply and campaign services, it would have been necessary to supplement American logistics with more than 200,000 workers.

On the Korean territory, the US hired over 107,000 workers across the area of operations without which it would have been impossible to carry out the activities of supplying the combat forces or executing the many infrastructure projects needed to ensure the communication and supply/evacuation routes. However, all these activities could not have taken place without careful supervision and monitoring of Korean workers. At the same time, American logisticians lacked the necessary expertise to employ, use and monitor the indigenous workforce and there were no clear procedures related to this process[2].

In this context, at the level of the US Logistics Command in the Area of Operations, a school was originally set up to provide Korean workers with information on US work methods, by field of activity. Later, however, this move turned out to be inappropriate, and the school became an institution for American logisticians who needed to gather information and learn the skills needed to monitor the Korean labor force[3].

Even if locally employed labor was also used on a much smaller scale in other previous armed conflicts, the conflict in Korea was a debut for awareness of the need to include indigenous workforce in the planning and execution of a military operation and, at the same time, for initiating procedures for the development of doctrines and procedures applicable to the contracting, training, organization, use and monitoring of workers.

The use of the outsourced workforce gained new valences in the *Vietnam War* (1961-1975). The particularly hostile territory in which the combat forces were operating, the lack of transport infrastructure, ports and airports, and the technological advance of the military equipment used, generated the need for highly qualified personnel to carry out the necessary infrastructure projects (from warehouses for materials and ammunition to landing sites – ports and airports, bridges and hospitals), the maintenance of weapons systems and aviation equipment and, last but not least, the provision of more and more base camp operations and services.

In this context, the first modern origins of contracting work and services to support military operations emerged. American companies such as RMK – Raymond Morisson Knodsen or BRJ – Brown & Root Jones, alongside the US Army and US Navy engineers units, have had outstanding achievements in terms of infrastructure projects carried out by 1969. Through sustained efforts, they managed to complete the construction and operationalization of 6 ports including 29 berths with different destinations, several airports, 20 hospitals and military bases that could accommodate 450,000 soldiers. In order to understand the rhythm of events, we can point out that in 1962, RMK had hired nearly 2,900 Vietnamese workers and, due to the large number of projects assumed, merged with BRJ in 1965, forming the construction consortium RMK-BRJ, which reaches in 1966 to have 52,000 employees, both Vietnamese and other neighboring countries, being involved in works in 50 locations in Vietnam[4].

In addition to the companies involved in the infrastructure projects, other specialized economic agents provided part of the base camp services as well as the maintenance of generators, pumps, under-pressure equipments and refrigeration units of all types. Of these, we can remember PAE – Pacific Architects and Engineers Corporation, which has reached 24,000 employees in Vietnamese territory during the war[5].

Throughout the war, in Vietnam there were active approximately 35 different economic agents, with between 130,000 and 150,000 employees, of which less than 5% were Americans, most of them being Vietnamese (about 83%) and other countries like Thailand, the Philippines, Japan or Taiwan (12%). Their use was a cost-cutting measure as well as an effective tool for supporting combat forces by using the expertise of both highly skilled and unskilled labor outside the military system. As a result of the experience gained in this conflict, in 1985 the LOGCAP – Logistic Civil Augmentation Program was set up in the US Army, which clearly states the possibilities of using civilian contractors both in peace and in crisis and war. In this way, their importance and involvement in military operations of all kinds grew more and more, as in the 1995-2004 peacekeeping operations in Bosnia, to operate one civilian for each US military, while in Afghanistan, in the years 2015-2016, their number reaches 3, for each service man[6].

In the absence of the use of this type of workforce in all areas of logistical support in operations, the military effort would have been enormous, consisting, among other things, in:

- the selection and additional recruitment of hundreds of thousands of soldiers, with all the shortcomings and implications of these activities, from the time required to carry out the procedures to the need for their actual funding and the payment of recruited staff;
- training the military in the simplest areas, such as the maintenance of a washing machine or a refrigerator and more complex ones, consisting in the design and construction of a port or the maintenance of electronically controlled weapon systems or combat aircrafts;
- deploying staff in theaters, with extensive implications for transport organization, reception, staging, onward moving to the final locations and integration into the planned logistic structure;
- planning and organizing work, monitoring workers, solving health and safety issues, providing work and safety equipment, etc.;
- rotation of staff in the theater of operations, redeployment and repatriation;
- solving the social, family and health problems of the soldiers both during and after the operation, including aspects related to reintegration, recovery and post-traumatic syndrome.

The human, material and financial resources needed to carry out these activities, as well as the time needed to execute them, would certainly have exceeded both the resources actually consumed by the contractors and the existing military means at that time.

Analyzing logistic support in military operations and related logistics footprint from another point of view, namely *supply*, there is to be taken into account one of the most innovative methods of fuel distribution, used and improved over time in the modern armies – distribution through pipeline systems from refineries or ports to logistic support lines serving combat structures.

This approach to fuel supply has been used since the Second World War by the US Army in the theaters of operations in North Africa and after landing in Normandy. In North African campaigns, over 1,600 kilometers of pipelines were installed in Algeria and Tunisia, while for landing in Normandy, six pipelines were planned to be set up from Cherbourg port, enough to carry 90% of the fuel used for the fighting forces to advance to Germany. In addition, in order to bring the fuel into the port, the PLUTO - Pipe Line under the Ocean system was set up, a system that crossed the English Channel, and a structure specifically designed for the management of pipeline systems in Western Europe was fully operationalized[7].

The system designed and used in the Second World War was later used in the same configuration in both Korea and Vienam, and only in 1983 underwent some changes designed to make it more mobile, efficient and easy to install. The old system consisted of 6 inch diameter metal pipes of about 6.1 meters in length and 85 kilograms, and the joining of them was made by bolts and nuts. Pipes in the new system configuration retained the diameter of 6 inches, but were only 5.8 meters long and 53.5 kg, their advantage being the lower weight – the material used was aluminum, the length – which made it possible to package the system in standard ISO-20 containers as well as the effective way of joining them using only one bolt, each pipe having an inner gasket to prevent leakage at joints. At the same time, the system as a whole gained in terms of the maximum allowable pressure in the plant, from 600 to 740 psi[8].

Following the completion of its research, testing and operationalization activities, the new system, called IPDS (Inland Petroleum Distribution System), was first used in operations in 1990 in Iraq, but proved its usefulness and efficiency only from the beginning 2003, also in Iraq, as part of Operation Iraqi Freedom. Initially planned to be built only on the Kuwaiti territory up to the border with Iraq, 164 kilometers of pipelines were built on two parallel routes, linking the Kuwait commercial fuel transport network to the US storage and distribution terminal positioned just 8 km away from the border with Iraq. With the two parallel systems fully operational, the storage and distribution terminal could have reached about 6,000 liters of fuel per minute, this ultimate terminal in Kuwait having a storage capacity of over 16 million liters, quantities that could convince any commander that the need for fuel for initiating the offensive operation was assured. With the entry of coalition forces in Iraq, the next stage of IPDS construction was initiated. Thus, from 20 March to 6 June 2003, the system was expanded with over 180 kilometers of pipelines, 10 pumping stations and 3 storage and distribution terminals with a total storage capacity of over 31 million liters[9].

The difficulties encountered in the operationalization and maintaining the transport capacity of the system were among the most diverse, starting from the landscaping, testing the pumping capability and verifying the tightness of the joints, to guarding and protecting it permanently, the system being often the object of sabotage or even theft of aluminum pipes.

The advantages of using the fuel transportation system are evident, with over 227 million liters of fuel being transported over the entire period of the conflict, equivalent to 22,700 10,000-liter tanks for which it should have:

- to arrange and maintained communication routes;
- to recruit additional staff for operation;
- to ensure maintenance, with all its implications, from spare parts to specialists in motor mechanics and for the special part of tanks;
- to provide additional fuel for operation (over 2 million liters);
- to ensure the management, guarding and defense of convoys, etc.

Another advantage of the system is that after the conflict, its components were largely recovered, maintained, preserved and stored, pending a new deployment in the theater of operations. At the same time, in addition to the considerable reduction of the resources involved and implicitly the costs, the use of this modern transport and distribution system made it possible to manage the fuel supply chain by a single structure for the whole theater of operations as well as respecting the principle of continuity of logistic support and the principle of sufficiency of resources necessary to achieve the objectives of the operation.

Analyzing the elements of the logistic footprint in the military operations reviewed, we can conclude that its reduction can not be attributed to a single entity in the organic military system. Only teamwork, intensive cooperation between all the structures and their involvement in peacetime research, innovation, operational testing and training can make the logistics of future military operations efficient and effective.

By addressing the logistics of the future and trying to figure out how the logistic support lines could look, including in their configuration specialized organizational entities and cutting-edge technologies, we find that the goal of reducing logistic footprint in military operations can be achieved, among others, through:

- efficient and effective stock management;
- effective and efficient management of supply / evacuation / repair chains;
- use of alternative energy sources;
- cooperative and shared use of resources.

*Efficient and effective stock management* in future military operations can be achieved primarily by knowing accurately and instantly the needs of forces in theaters of operations. Involvement in the information logistic system of artificial intelligence through the implementation of data monitoring and integration systems up to the smallest team or crew type on a combat machine that will continually and automatically transmit information related to the number of kilometers traveled, fuel, ammunition use, and even the need for spare parts for the next planned maintenance work will generate major changes in logistics support approaches. Thus, after a single order, the commander will know precisely, at each moment, the level of logistic support, the urgency and the supply priorities for all classes of materials, the ultimate purpose being to relieve the fighting units of the logistic bureaucratic responsibilities, to ensure on time the needed assets and only in the quantities strictly necessary to achieve the objectives, avoiding the creation of unnecessary stocks at their level.

At the same time, the removal of intermediate links in the supply chain will lead to a reduction in the logistics footprint by creating a slim logistic system, minimizing financial pressures, suppressing supernormal stocks, responding more quickly to the requirements of the beneficiaries, and mitigating the impact of possible malfunctions before their occurrence[10].

From the *supply / evacuation / repair chain management* point of view, a noticeable impact will have the implementation of the distribution-based logistics (DBL)[11] concept. Also, the widespread use of the drones with increasing autonomy and transport capacity will increase existing logistics capabilities. In future conflicts, with the use of advanced precision weapon systems capable of striking long-distance targets, effective maneuvering of fighting and supporting units will be decisive. For this reason, supply operations will have a different dynamics, and the development of capabilities that can distribute certain quantities of material, food, water or ammunition in hard-to-reach areas at high speed and without endangering life and integrity of the operator, is not only necessary but even imminent.

As early as 2016, the JTAARS – Joint Tactical Autonomous Air Resupply System was launched in the US Army, a capability consisting of logistic transport drones with the primary mission of supplying the tactical subunits isolated or in contact with the enemy with 150 to 300 kilograms of various materials. Decentralizing the use of these assets from higher hierarchical levels and integrating them into the logistics companies' structure is a desideratum that will bring benefits in terms of mobility, vulnerability and capacity to use every opportunity to supply in a hostile, dynamic and ever changing environment, characteristic of future military operations [12].

The use of unmanned aerial systems of all types with size, autonomy and variable transport capacities in logistics operations will have an impact not only on the supply but also on other aspects of supply / evacuation / repair chain management, such as: evacuation of wounded and sick persons, surveillance and investigation of communication routes and crossing points, including chemical, bacteriological, radiological and nuclear research, transmission of mail or postal parcels, etc[13].

But the influence of the technological achievements of recent years on the logistical support of military operations and supply, evacuation and repair chain management, does not stop here. Certainly, the military logistic system will evolve, following the pace of technological advancement, by implementing other innovations, such as:

- the leader-folower convoy system with the first vehicle driven by an operator and up to 10 other vehicles that, using sensory-based artificial intelligence, track the leader to the final destination;
- using 3D printers as a source of supply of different kinds of hardware and spare parts for the battle technique, with important effects related to shortening supply lines and performing repairs on the spot without evacuation or lost time waiting for the necessary spare parts;

- using video maintenance through drone-assisted videoconferencing systems that transmit video information from the defective vehicle to a specialist hub that can guide the operator to repair faults by repairing or replacing the defective subassembly with an existing or three-dimensional printed spare part.

And how would all these elements be shown in the logistic support lines of a military operation if they were autonomous or semi-autonomous in terms of energy? *The use of alternative energy sources* (solar, wind energy, hydropower or tidal energy, geothermal energy) and the implementation of procedures and means of obtaining it in military operations may seem for the time being too optimistic and daring, but the benefits thus obtained would translate in terms of mobility and broader freedom of action on the part of combat forces on the one hand, and on the other hand, the economy, efficiency and effectiveness of the logistics system by obtaining a supple logistic footrprint, in the absence of supply, storage and distribution of conventional fuels as the main source of energy.

Exceeding the technical and technological innovations, I have also stated that a reduced logistic footprint can be achieved by *cooperative and shared use of resources* at its disposal. We understand through this concept, streamlining structural and procedural organization, especially within a joint/ multinational forces, in order to allocate the existing logistics resource, regardless of its origin or nationality, to all the components and nations involved. For this, the resources involved, regardless of their nature, must respond primarily to the principle of the single command, so that the commander can dispose of the maneuver and its distribution to the subordinate entities without restrictions and at the same time, there should be clear responsibilities for realizing the integrated logistic picture of the theater operations in its entirety. Modern structural entities, adapted to the current context, are in the process of integration and development, both at NATO level (JLSG - Joint Logistic Support Group) and at national level. The use of the resource in this way, manifests its necessity especially in the field of movement and transport, not only at the strategic level, but also at the tactical level for the supply and replenishment of the units.

All technical or procedural efforts aimed at achieving efficient logistics support in current military operations will certainly reflect on the success in achieving goals and sizing logistics footprint. Setting up flexible logistic support lines, in addition to cost advantages, generates real operational benefits in facilitating command and control activities as well as mobility, security of operations and the protection of logistics forces.

**NOTES:**

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