

# Digital technologies used in the field of military transport

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## Abstract

Military transport as a sub-field of operational logistics ensures both the movement of forces from one location to another as well as their supply and support during military exercises or operations. Ensuring the transportation of materials to the fighting forces at the right time and place, as well as in the necessary quantity, is essential for the successful completion of missions. In this regard, during the planning process for force support, determinants such as destination, duration, distance, and the logistic support demand for the operation are taken into account. Technological evolution allows for the adoption of digital solutions in the logistics field, with the following benefits: reducing the risk of human losses, access to difficult locations, visibility over transported goods, and increased speed of response to logistic support requests.

The purpose of this article is to highlight a series of digital technology solutions applied in the field of military transportation. To write this article, a qualitative research strategy was applied to gain an in-depth understanding of the phenomena and processes related to military transport. The data collection technique used was the analysis of manuals, regulations, doctrines, articles published in journals and magazines, media content, websites of digital technology developers, and specialized books.

The conclusion of the article lies in highlighting the advantages of using robotic technology to ensure military transport.

## Keywords:

transport; military; sustainment; digital solutions.

### Article info

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Transport activities are carried out in support of the armed forces, with the purpose of their movement and providing the necessary logistics support for mission fulfillment. According to the "Instructions on the movement and transportation operations of large units and military units" manual, operational requirements for efficient transportation aim at adaptability to existing situations, flexibility to respond to force support requests, and the ability to interrelate its components ([Ministerul Apărării Naționale 2014, 3](#)).

Fulfilling the mission of transporting materials to the fighting forces at the right time and place, as well as in the necessary quantity, is essential for the success of operations. In this regard, during the process of force support planning, logistics planners take into account determinants such as *destination*, *duration*, *distance*, and the logistic support *demand* for the operation.

The current challenges require identifying new solutions in the field of robotic technologies to provide forces with goods and services at any time and in any situation. In the current technological development context, the use of digital solutions plays an important role in the defense industry sector. Not only the military environment witnesses such developments but also the private business setting, especially in the logistics field, experiences surprising evolutions in technological domains, under the auspices of competitive factors and available resources.

The military logistics sector can benefit from technological advancements to decrease human losses due to activities in hazardous zones, reduce the execution time of logistical activities, mitigate losses due to logistical errors and delays that may occur in the supply chain, and increase the transparency level of logistics operations by ensuring visibility of goods.

Studying specific solutions of robotic technologies used in the private sector and in the logistic systems of other armies can lead to transformations in terms of predictability, transparency, and efficiency of the activity field. The advantages consist of enhancing operational efficiency by providing necessary materials to forces in the shortest time, reducing risks associated with transporting goods in hostile operational zones, and reducing the dependence on human labor.

To elaborate on this article, a qualitative research strategy ([Șandor 2013, 51](#)) was applied for a deep understanding of the phenomena and processes in the field of military transport. The methodology was also applied to gain detailed knowledge of technologies in the digital transportation sector.

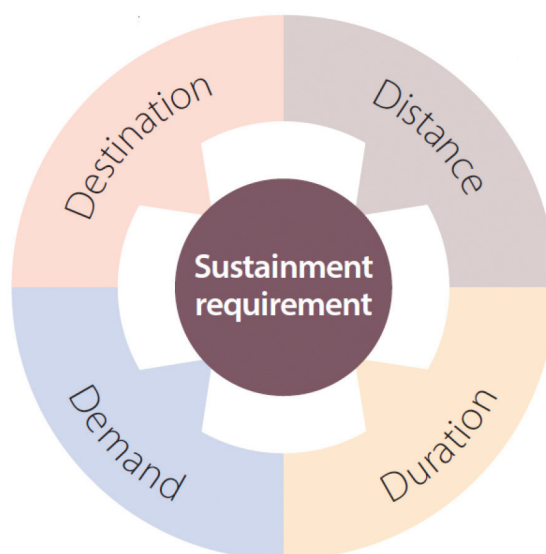
For this purpose, the data collection technique used was the analysis of various manuals, regulations, doctrines, articles published in journals and magazines, media content, websites of digital technology developers, and specialized books.

## Logistic planning through the 4D formula

In the context provided, the text discusses the operational logistics planning perspective through the 4D formula. Starting with the definition of logistics as a managerial science, according to the „Unified Logistics Doctrine of the Romanian Army” (S.M.Ap. 2023, 12), it is broken down into three elements (production logistics, support logistics, and operational logistics), organized along four lines of logistic support. From this perspective, the article’s focus is on operational logistics, a component responsible for ensuring military forces with the necessary services and goods for the uninterrupted conduct of military actions.

Among the main objectives of operational logistics, timely and secure provision of goods and services, maintenance services for military equipment, support for changing the location of military forces and materials, movement and transportation of personnel and materials, operational medical support, host support assistance, and the utilization of contractor support are enumerated (S.M.Ap. 2023, 28).

Operational logistic support entails providing combat forces with materials and services (medical evacuation, equipment repair evacuation, campaign services) at the “right time and place, in the necessary quantity and quality” (S.M.Ap. 2023, 19). The execution of logistic support is based on a conception that is the result of the logistical planning process. As per the “Manual of logistic support in joint operations,” the factors influencing the logistics planning process are determined by destination, duration, distance, and the logistic support demand for the operation (C.L.I. 2007, 10). This approach can also be found in the support concept of the British Army. For example, the “Joint Doctrine Publication 4-00” presents the formula of the “four Ds”: demand, duration, distance, destination, as simplified in Figure Number 1 (M.o.D. 2015, 156).



**Figure 1** The four Ds – demand, duration, distance, destination (determining factors for logistic planning) (M.o.D. 2015, 156)

According to the figure, the *destination* refers to determining the requirements for providing logistic support. Thus, in the process of planning military transport, factors such as access to infrastructure in the operational area, the level of its development, or the presence of civilian contractors are considered. *Distance* is a factor from which considerations regarding the length of transport routes, the time required for transport, transport capacity, and topographical elements can be deduced. The *duration* of a mission generates varying efforts for logistic support. Therefore, planning logistic support for a short-duration mission considers different elements than those for supporting forces in a long-term mission. An example of this is the African Union Mission in Somalia in 2007 (Major and Strickmann 2011, 6), where the initial six-month mission mandate was extended, and the initial logistic support planning required adjustments to meet the new requirements. Meeting the *demand* is a challenge for logistic support planning, as it requires accurate forecasting of resource consumption for the operation's completion. Demand estimation takes into account both the intensity of combat and the mission duration, which place additional strain on logistic support.

These aspects need to be considered in military transport planning, given the challenges that can be encountered in providing logistic support during the mission.

### **Challenges for transportation in order to support troops in operations**

Lessons learned from ongoing conflicts show that the current military operational environment is becoming more complex and dynamic than in the past, and logistic support is subject to much more difficult-to-forecast factors. Nevertheless, some logistical challenges of past centuries faced by military commanders remain relevant today (Clausewitz, et al. 1984, 340). In the cited work, Clausewitz describes the conditions under which troop logistic support is carried out with difficulty. The author presents these aspects from the perspective of the commander of the force conducting offensive actions, in other words, from the attacker's point of view. From experience, he recognized that at the moment of initiating an attack, the attacking force conducts combat actions with an increased rate of material consumption. However, resupply needs may be difficult to meet, given that the necessary goods cannot be transported at the same pace as the offensive operation. To prevent delayed resupply of troops, Clausewitz recommends rigorous pre-planning of resource deployment.

The author details another moment when logistic support can be provided with difficulty. At the end of a successful military campaign, the lines of communication between the frontline forces and logistic support forces can become very extended. As Clausewitz observes, providing logistic support over very long distances, in

hostile environment, can lead to a loss of initiative or even withdrawal of forces from captured positions. Similar observations were noted in the early weeks of the Russia-Ukraine conflict. Considering that the armed forces of the Russian Federation managed to successfully exploit the surprise effect of the attack, the increased tempo of the operation led to rapid advancement into Ukrainian territory, nearly reaching Kyiv. Thus, the high rate of ammunition and fuel consumption, along with the extended supply and transport lines, posed challenges to the continuous provision of logistic support for Russian troops. The logistical convoys loaded with necessary supplies for the Russian armed forces did not reach their objectives, leading to the withdrawal of Russian troops from captured positions. The causes of the convoy stoppages were numerous, including the extended length of supply lines ([Martin, Barnett and McCarthy 2023](#), 7-8).

These aspects observed by Clausewitz during the Napoleonic wars are still relevant today in the principles of logistic support, representing current elements for operational planning as found in the “Joint Operations Logistics Regulation” ([Ministerul Apărării 2008](#), 3).

## Digital technologies applied in transportation

Today, military operations tend to develop multi-domain capabilities ([NATO 2023](#)), requiring appropriate logistic support. As mentioned earlier, it is not a novelty that military operations are conducted faster than the logistic forces can support the armed forces. The evolution of technology drives new trends in the conduct of armed conflict. The use of advanced technologies such as long-range unmanned aircraft systems (UAS) that can identify targets thousands of kilometers away presents a significant potential for revolutionizing military affairs ([Gupta, Ghonge and Jawandhiya 2013](#)). Additionally, satellite imagery ([Planet.com n.d.](#)) can be easily accessed, providing precise information on the positions of armed forces and their changes within minutes. It can be said that military actions in the tactical field are conducted under conditions that can be visible to interested parties.

To meet current operational requirements, a more flexible, efficient, and adaptable approach to managing logistic support is needed, according to the basic principles of the Romanian Army's logistics ([S.M.Ap. 2023](#), 20).

We will further refer to several technologies applicable in logistics, such as robotic systems for logistics, autonomous vehicles, and radio-frequency identification technologies.

*Robotic systems* used in logistics aim to improve the efficiency of the logistic system by increasing the accuracy and speed of logistic operations ([Bi, et al. 2024](#), 245). In the European Union (EU), industrial companies continuously invest in developing and implementing robotic solutions. According to the President of the International Federation of Robotics (IFR), Marina Bill, the top five EU countries leading the

way in robotic systems are Germany, Italy, France, Spain, and Poland. These five countries use approximately 70% of all industrial robots installed in the EU in 2022 ([IFR Press Room 2023](#)). In the military system, current trends focus on developing and evaluating robotic systems specifically designed for military logistics operations. For example, there is interest in autonomous transport vehicles ([Milrem Robotics n.d.](#)). THEMIS (Tracked Hybrid Modular Infantry System) is an unmanned ground vehicle (UGV) developed by Milrem Robotics with the support of the Estonian Ministry of Defense to perform multiple missions ([Army Technology 2024](#)). Other technological developments are noticeable in the drone sector, robotic manipulators, and automated storage and retrieval systems. The United States Marine Corps intends to equip logistic units with tactical resupply drones, such as TRUAS (Tactical Resupply Unmanned Aircraft System), by 2028 ([Skove 2024](#)). These systems have been used by the armed forces of the Russian Federation and Ukraine for material supply and casualty evacuation ([Burgess 2024](#)). The main benefits of such technologies include eliminating human losses due to exposure to enemy actions, accessing various locations even in complex operational environments, reducing resupply time, and improving logistic support efficiency ([McKay, et al. 2020, 7](#)).

[McKay et al \(2020, 49\)](#) addresses in the paper “Automating Army Convoys” the opportunities and risks from the perspective of using autonomous vehicles in military convoys. According to the authors, transport missions in military operations involve traveling long distances on unsecured routes. For this reason, transport means are vulnerable to enemy attacks and ambushes in non-linear and non-contiguous operational environments that generally do not have secured rear areas. Experience in the theaters of operations in Iraq and Afghanistan highlighted these vulnerabilities: army convoys suffered heavy losses while traveling hundreds of miles on unsecured distances. The main opportunity derived from these experiences is the possibility of protecting military personnel from such dangers. The risks to the implementation of autonomous vehicles refer to a “technical immaturity” of these projects ([McKay, et al. 2020, 13](#)).

Digital and robotic technologies are solutions adopted to improve the *supply chain* by managing inventories, forecasting material demand, designing distribution networks, and optimizing transport to enhance efficiency and response speed. Armies of countries such as the United States, Brazil, or Australia run programs that ensure the traceability of material goods ([Roberti 2013](#)). For example, the possibility of identifying products by allocating a unique code (Unique Identification/UID). Also known as IUID (Item Unique Identification), the system serves to differentiate items from other similar elements to facilitate the exchange of logistic information. This program requires a unique and specific number to be assigned to tangible equipment owned by the government, according to the publication “Army Regulation 700–145 Item Unique Identification” ([Department of the Army 2020, 5](#)).

Other ongoing programs aim to implement a set of *radio frequency identification* (RFID) technologies for material goods and equipment. To successfully carry out missions, armed forces must be continuously supported with materials and equipment, including food, weapons, ammunition, fuel, spare parts, medical products, etc. RFID technology can improve supply chain operations by confirming that the appropriate items have been picked up and shipped at the right time. Additionally, RFID systems allow for updates with information indicating the location of goods and the time when the item tags were scanned, ensuring visibility in the locations where they are stored ([mojix.com](https://www.mojix.com) 2019).

## Conclusions

Transport activities are carried out to support the armed forces, facilitating their movement and providing the necessary logistic support to accomplish missions. Operational requirements for efficient transport include adaptability to existing situations, flexibility to respond to force support requests, and the ability to interrelate its components.

Technological advancements for improving transport include autonomous transport through the use of drones and unmanned vehicles. These can be applied by military logistics to ensure material transport and supply for forces in hard-to-reach or unsecured areas. New technologies ensure faster and safer transport, eliminating the risks associated with human presence in such zones.

Robotic technologies can be used to automate logistic operations, such as handling and moving goods, loading and unloading vehicles, and quickly identifying and locating materials. The benefits brought relate to reducing human losses due to exposure to enemy actions, decreasing dependency on human labor, increasing logistic efficiency, and speeding up response times to logistic support requests.

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