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A CONSIDERATIONS ON THE FACTORS GENERATING INCREASES IN THE LIFE CYCLE COST FOR MILITARY EQUIPMENTS

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Abstract:
When analyzing the purchase of military equipment, the commissions should be composed of a wide range of specialists, which should be taking into account all aspects of the equipment, including its cost throughout its lifespan.
Lack of information in these committees, lack of understanding of the concept of life cycle cost, the focus on short term considerations, lack of an integrated view regarding the life cycle cost of an equipment from its acquisition to the end users, lack of correlation between military considerations and economic considerations are just a few of the risk factors that lead to increases in equipment costs over their life cycle.

Key words: life cycle; integration; short term; military organization; management.

1. Introduction

There are several standard definitions of the life cycle for equipment, but over time a number of definitions have been given which cover all aspects of the equipment starting from the initial concept to its withdrawal.

According to the SR EN ISO 14040:20022 standard, life cycle is defined as „the *consecutive and interrelated stages of product-system, from the acquisition of raw materials or the generation of natural resources until post-use*".

In my opinion, the life cycle of military equipment should include, in addition to the requirement of equipment stage, the stages of the supply with raw materials, their processing, the analysis and design phase, manufacturing, distribution (including maintenance during service, supply of spare parts) stages of using the equipment, its removal and disassembly its recovery, as well as processing the resulting waste.

In the current political context, the military and economical relevance of the subject has increased and the increased efficiency in using the life cycle cost analysis leads to the provision of equipment with a longer lifespan and an adequate cost.

By including the cost of the life cycle in the process of acquisition, the managers can take the best affordable decisions by choosing from the presented options on different stages of the life cycle and based on their estimated costs. The phases of the life cycle of equipment are presented below in figure 1:

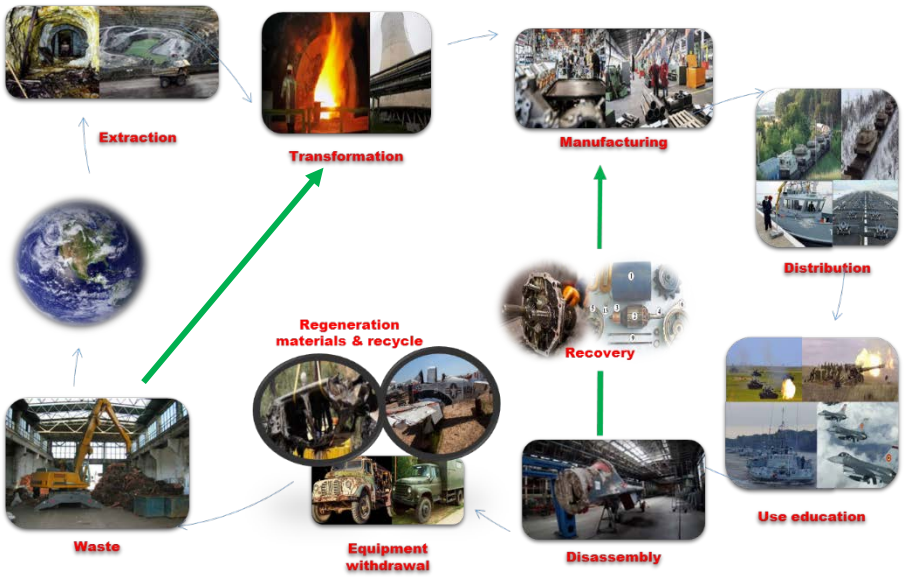

Fig. 1: Equipment life cycle phases

2. Considerations on the cost implications of the process of equipment acquisition, operation and modernization

The acquisition of military equipment is determined by the country's defense policy, which should take into account not only the defensive purpose of the equipment, but also the possibilities of equipment being used for offensive purposes when the situation requires it.

Following the decision by the Supreme Council of National Defense on the type of required equipment to be purchased or manufactured, it is recommended that all other relevant aspects related to the equipment should be analyzed down to the smallest detail, by a team of subject matter experts from the Armaments department, which should also include research specialists. This team should analyze and compare all the technical characteristics and the requirements the future equipment should meet, and the conclusions will subsequently be presented to the Supreme Council of National Defense, in order to provide clarifications and make changes to the equipment requirements (if applicable). After that, following the review process, a decision shall be made regarding the type of equipment to be purchased / manufactured.

In this respect, the possibilities of modernizing the equipment must not be omitted, nor should the associated costs. If the contract agreed between the parties (producer/end user) does not specify from the start the costs, and the various aspects related to the modernization of the equipment, in accordance with technological evolution, the risk that the update cost will increase up to half the cost of the initial equipment should be taken into account.

At the same time it must be specified in the contract that the training of a minimum number of staff (training instructors) which are going to utilize the equipment is to be done on the expense of the manufacturer or using common costs.

The training rooms and laboratories used by the staff tending to the equipment should be equipped with complete and separated subassemblies of gear, simulators for training the operators, presentations of the equipment in different stages of application. This assets should be provided by

the manufacturer, as they are the only ones who have the necessary information, after testing the equipment and monitoring its use in different work environments.

1.1: Equipment manufacturing location

A very important aspect related to the production of the military equipment which I want to emphasize is the location where the equipment as well as its component subassemblies are produced and what important raw materials are needed for manufacturing the equipment components It is a common practice that equipment of any kind, and especially the military equipment's, should be purchased from a business-friendly country which has the same defense policy approach and which is engaged in military, political and economic cooperation with the beneficiary country.

Even if the analysis of the work teams concludes that a specific equipment fully meets all the required features and the acquisition costs are below the market price, it should also be taken into account who produces it, where it is assembled, where the consumable and material goods necessary for the operation of the product come from. It would not be advisable to purchase an equipment I it is produced or assembled in an unfriendly country or if that country is in a very distant location, and the delivery of the equipment or consumables would require crossing hostile countries borders or areas such as unavoidable crossing points (oceans, canals, straits, etc.) or highly politically controlled areas.

At the time the microchip crisis occurred, the countries that did not anticipate it or weren't presented with the opportunity of purchase for stock creation, were forced to reduce their production capacity or even close entire factories.

It is entirely probable that the manufacturer chosen for the military equipment could also be unable, in some specific circumstances caused by a natural disaster or man-made crisis, to purchase certain raw materials (for various reasons: its lack of presence on the market, or the supplying country entering conflict with the producing country).

1.2: The real cost of military equipment

A standard definition of the real life-cycle cost of equipment cannot be rendered as a literary expression, as it is more of a mathematical equation, which includes many known factors, but also many other unforeseen or obscure factors that can vary from one stage of the product's life cycle to another and can substantially increase the cost.,.

Therefore, when talking about the real cost of the equipment, the whole set of planned and hidden costs, calculated and deducted from the entire life cycle of the product (even in the phase of disposal and recovery of the equipment or its subassemblies) must be taken into consideration.

A mathematical equation of the life cycle costs of equipment can be represented as follows:

$$\mathbf{LCC = a + bx + cxy +/- d}$$

Where:
a = one-time system costs (R&D)
b = one-time unit costs (Acquisition)
x= number of units
c = recurring (annual) operating costs
y= number of years operated
d = disposal costs (+) or residual value (-)

3. Developing the defense industry and the national economy through producing military equipment inside the country

Another aspect that should not be neglected in relation to the production of military equipment and which I would like to emphasize is that the manufacturing should preferably take place in the respective country. This will lead to the development of the defense industry and the national economy by creating jobs and industrial infrastructure progress, but also to the possibility of providing equipment to other countries, all this leading to an increasing of the gross domestic product and implicitly of the living standard of the population.

Trucks are currently being produced in Romania since the last generation, but we used to buy trucks from our Italian partners. Italy's higher economic power meant that the producer could also provide the maintenance for the purchased truck, something the Romanian producers could not provide. The decision also had the advantage of facilitating the interoperability in the joint exercises carried out between our country and other partners Although the purchase of the necessary equipment from foreign producers has undeniable advantages, it would be perhaps better to consider a mixture of foreign and domestic producers when choosing the supplier for the equipment needed to modernize the land forces. .

Taking into account the modernization requirements of the Romanian Armed Forces, which for a period of about 50 years was equipped with assets of Soviet origin, the analysis of costs during the life cycle of equipment failed to take into consideration the following aspects:

- **The type of fuel used for the military equipment**. It is important to mention that apart from the air force, which uses a unique fuel for the aircrafts and the helicopters, all the other services also use diesel fuel (both in the summer and winter), gasoline and many other types of combustibles and lubricants. Using different types of fuel can generate problems during an armed conflict, as it would not be possible to use the resources from a damaged technique (cannibalization), as the fuel type and spare parts would not fit. On the other hand, even during peacetime, the lack of standardization increases the difficulty of the purchasing process and the problems to be overcome in relation to the storage the fuels and the lubricants. (Figure no. 2)

Figure no. 2: Types of power supply and chassis

- The chassis type of armored and unarmored military equipment. Similarly to the aspects mentioned above, trucks do not have the same type of chassis, the same type of wheels, engines and other components, with significant differences from one military structure to another. The armored vehicles have different chassis and different driving components, which also leads to the same inconveniences related to the acquisition, storage and reuse of the subassemblies taken from damaged equipment as mentioned above. An increased standardization of the same class of equipment, at the level of all the military units within a service, would significantly improve the operational effectiveness and also reduce costs, through savings related to economies of scale regarding acquisition of fuel and spare parts and reduced storage costs.

From the perspective of the life cycle cost, there are numerous arguments in favor of acquiring and maintaining the military equipment using domestic suppliers. This approach would have the added benefit of encouraging the economic growth, by stimulating domestic producers, but this approach should be a comprehensive one, including the development of the roads and railway infrastructure required for increasing the effectiveness of supply and maintenance.

In conclusion, the use of a wide variety of military equipment produced in different countries generates difficulties and additional costs, deriving from maintenance challenges, increased cost and high complexity of the acquisition process for a very diverse range of consumables, from the storage costs, from the additional costs generated by training operators for a high diversity of equipment, but also from the opportunity cost of not stimulating the economic and industrial development of the country.

4. Risks related to the acquisition of military equipment and their associated costs

In the contents of the paper I would like to emphasize three types of risks related to the purchase of military equipment and their associated costs, over the lifespan of the equipment.

According to the International Organization for Standardization (OISS) *ISO 31000 (2009) / Guide ISO 73:2002* ***risk*** *is defined as „the effect of uncertainty on objectives". Uncertainty implies events which may or may not occur and the uncertainties caused by ambiguity or lack of information.*

The first type of identified risk would be the **assumed risk.** The costs generated in this case would close to what is predicted and are easily affordable throughout the life cycle of military equipment.

Hidden risks. These type of risks lead to increased costs, sometimes even over half the value of the initial price of the equipment, and the impossibility of using the equipment at maximum capacity.

The following examples refers to the purchase of military equipment, which led to unforeseen costs deriving from hidden risks:

- Portable radio stations were purchased within a brigade, yet they were not bought from the same manufacturer (HARRIS and PANTHER). The attempt to use them to communicate in secret (frequency hopping, a very important feature for a radio station) failed, as they were not compatible, so the units could not communicate secretly with each other. Also, the initial acquisition of the radio stations did not include the required cables for data transmissions. These were purchased later, in a separate transaction, for a substantially increased price.

- Another example refers to the acquisition of SPIKE-type weapon systems, whose ammunition must be kept in warehouses that maintain a certain minimum temperature. These additional costs were not taken into consideration initially leading to an increase in the overall life

cycle cost compared to the estimated one. **Unforeseen risks.** These type of risks seems to me to be the biggest generator of unforeseen costs, for instance through blockages that may occur, leading to the impossibility of providing raw materials for the production of equipment and causing increased costs related to the purchasing of the raw material or other components or even at the closure of production lines.

An example of unforeseen current risks would be the microchip crisis used in the automotive industry, avionics, IT, home appliances, etc., generated by the unforeseen risk of the COVID 19 pandemic, which diminished the production capacity in various industries.

Another current example in our country it is the issue of the crisis of the special type of plastic used for identity cards, with broad societal impact: people with expired documents cannot travel abroad anymore, they cannot make real estate, financial, or any other transactions.

5. Conclusions

A final conclusion is that when analyzing the purchase of military equipment, the commissions should be composed of a wide range of specialists, which should be taking into account all aspects of the equipment, including its cost throughout its lifespan.

Lack of information in these committees, lack of understanding of the concept of life cycle cost, the focus on short term considerations, lack of an integrated view regarding the life cycle cost of an equipment from its acquisition to the end users, lack of correlation between military considerations and economic considerations are just a few of the risk factors that lead to increases in equipment costs over their life cycle.

The well-known Romanian principle *that we are too poor to buy cheap things*, in other words *marginal costs equal to marginal benefits* could be a good guideline in relation to the acquisition of equipment required for the modernization of the armed forces.

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