LOGISTICS ASPECTS OF WEAPON SYSTEMS MODERNIZATION

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Abstract

Problems of logistics support of weapon systems in their life cycle operation and support phase, especially considering its modernization are presented in the paper. In the introduction inevitability of the modernization process of crucial weapon systems was emphasized. Furthermore, the concept of weapon system, life cycle of the weapon system and modernization of weapon systems where presented. A general description of a model of the process of creating the plan of technical modernization of the Polish armed forces was also presented. The main part of the article presents the areas of logistics that should be newly tailored to the needs of the modernized weapon system. These basic areas include: processes of operation and maintenance, material and technical supplies, staff acquisition, availability of service devices, creation of databases, organization of trainings, computerization, logistics infrastructure, dedicated transport means. The main conclusion of the article is to emphasize the fact that the modernization of weapon systems entails not only the costs of modernizing a specific type of weapon (tank, infantry fighting vehicle) but also the costs of logistic support in operation and maintenance phase of their life cycle.

Keywords: Weapon system, life cycle, modernization, logistic

1. INTRODUCTION

The inevitability of the modernization process of crucial weapon systems (WS) is primarily due to their at least 30 years of operation. During this time, at least two factors affect the failure to adapt their ability to current requirements [1-3]. The first is the changing threat that these systems should counteract, and the second is continuous technical progress enabling improvement of key parameters affecting capabilities of these systems [4]. As it results from the above, it is necessary to implement actions aimed at adapting the capabilities of WS to current requirements of modern battlefields.

The modernization of WS is seen through the modernization of their key subsystem - a type of military equipment. That is why in the further part of the article the concept of modernization of the WS and modernization of military equipment is presented similarly.

Rational management of the life cycle of defence systems (including WS) is extremely important due to the very high costs of the life cycle of these systems (reaching hundreds of billions of US dollars) [5,6].

But the problem of technical modernization of the WS is not only a purely technical issue but often a political will. Such a flagship example in the Polish Armed Forces is the BWP-1 infantry fighting vehicle. It should be noted, however, that just a few years after the BWP-1 was put into operation (1966), work was undertaken to modernize it, and in many countries its modernized, proprietary versions (e.g. Romania, Slovakia, Belarus, China) are currently in operation. Leaving in the service of the unmodernized BWP-1 poses huge logistical problems with its maintenance.

Despite this infamous example (BWP-1 in the Polish Armed Forces), the standard is to modernize weapon systems (even several times) before deciding to withdraw them from service. Hence the importance of this process in the life cycle of weapon systems.

2. MODERNIZATION OF WEAPON SYSTEMS

The WS is defined as a set of cooperating weapon types (along with their related equipment) with personnel, material and technical means, services and means of transport/shipment (if required). The above-mentioned elements are to ensure self-sufficiency of the WS, defined by the type of weaponry, in operation [7]. A graphic presentation of the concept of weapon system is shown in **Figure 1**.

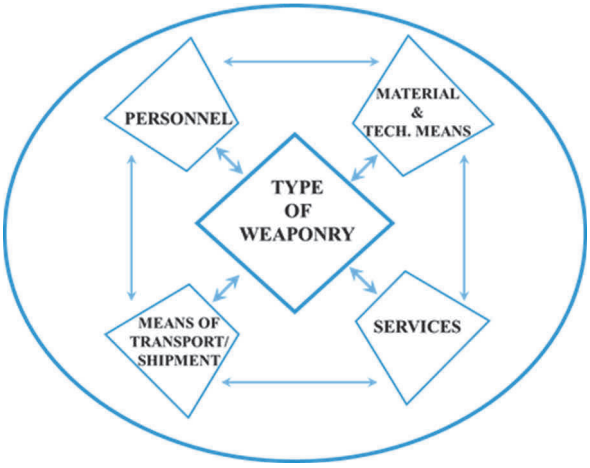

Figure 1 The idea of weapon system

In NATO, by adapting the classification set out in ISO / IEC 15288, the entire product life cycle has been divided into six stages: concept, development, production, use, support, withdrawal.

However, according to the model adopted by the Polish Ministry of National Defense, the life cycle model of the WS includes the following phases (**Figure 2**): identification, analytical and conceptual, implementation, operation and maintenance.

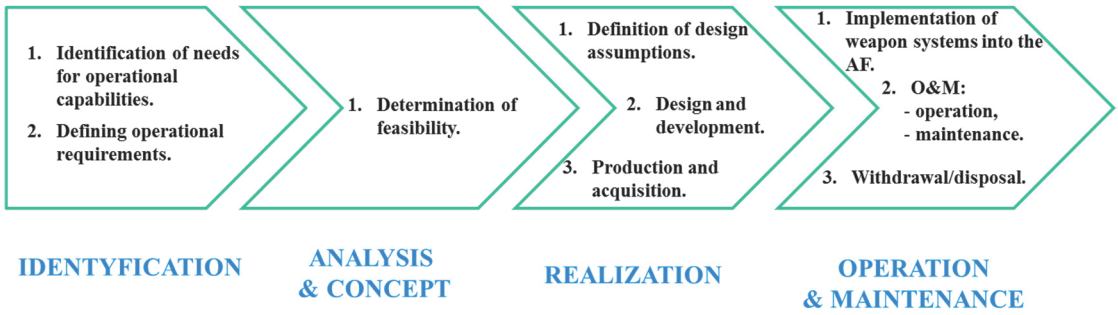

Figure 2 Graphical presentation of weapon systems life cycle processes in Polish Armed Forces

WS modernization process in its life cycle is generally carried out in two phases, realization and O&M. In the realization phase, in the area of modernization, it is important to design the future WS in such a way that its further rational development is possible. In particular, it is about the possibility of increasing the capabilities of WS by replacing critical modules (assemblies, subassemblies).

The completion of the last stage of the WS life cycle in the Polish Armed Forces is subject to its decommissioning, if it does not meet the requirements of the Armed Forces due to at least one of the following conditions:

- utilize worktime standard,
- physical wear and tear, preventing further use when the repair is unprofitable or impossible,

- combat, technical and operational parameters that do not meet the requirements of the army when **modernization is unprofitable or impossible**,
- organizational and regular post changes in the Armed Forces, resulting in no prospects for the WS further operation.

According to the current nomenclature in the Armed Forces of the Republic of Poland, the increase in the capabilities of WS can be achieved through the process of its modification or modernization. Both processes mentioned above take place in the O&M phase of the weapon systems life cycle.

Modification is understood as the process of improvement of WS, consisting in the exchange, replacement or extension of existing components, functions or software without changing its principal purpose. As a result of the modification, no new WS is created (i.e. it maintains its existing material index). Good example of this process is overhaul and modification of T-72M1 tank.

Whereas, the modernization process, which is also a process of improvement of WS capabilities, involves changing its operational parameters. Especially critical operational parameters. As a result of this process, new WS is created (receives a new material index). As an example of this process may serves modernization of Polish Leopard 2A4 tanks to Leopard 2PL version.

As follows from the above, the modernization of WS significantly changes its capabilities and is a much more complex and costly process than the modification process. Therefore, the frequency of execution of the WS modification process is definitely greater than its modernization.

Thus, the essence of the modernization of WS is to increase its capability, combat value (**Figure 3**).

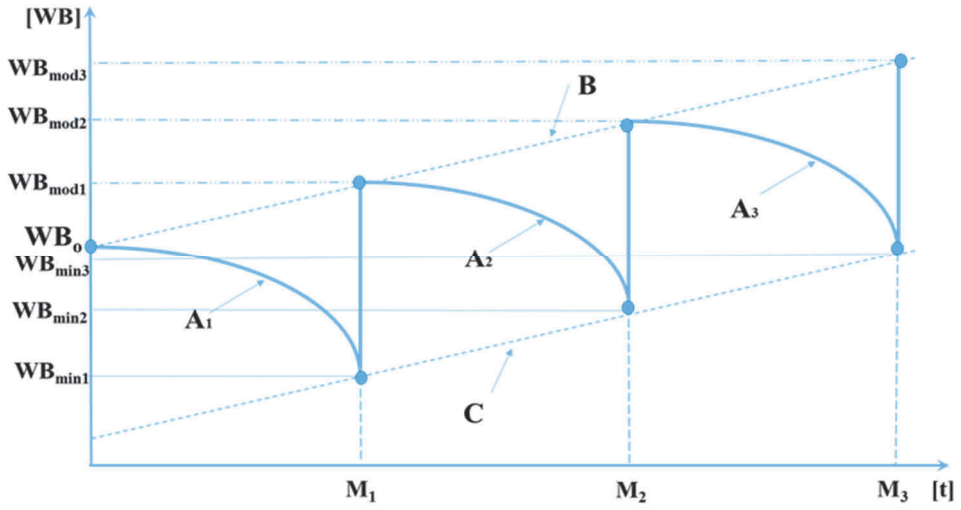

Figure 3 Graphical presentation of the process of modernizing a weapon system (the meaning of symbols in the text)

The initial combat value of WS is WB_0 at the time of its entry into service. The decrease the combat value of WS during its operation is symbolized by the A_1 curve. This decrease continues to the contractual allowable level of combat value (WB_{min1}). In order to prevent exceeding the allowable level of combat value, the modernization process (M_1) is carried out, thanks to which the combat value of WS increases to the value of WB_{mod1}. A significant fact is that the level of combat value of military equipment after modernization (WB_{mod1}) is higher than its initial level of combat value (WB_0). The relationships presented above are repeated in time (WB_{min2}, WB_{min3} - admissible levels of combat value decline after modernization of M_2 and M_3; A_2, A_3 - curves of the decrease in combat value after modernization of M_2 and M_3; M_2, M_3 - subsequent modernizations; WB_{mod2}, WB_{mod3} - a level of military equipment combat value after the modernization M_2 and M_3).

Of course, the cyclicity of changes is not equal for each time interval. Also the lines symbolizing the change (increase) in the level of allowable combat value (line C) and the level of combat value after modernization (line B) may correspond to the value of various functions (this is not always a linear function as shown in the **Figure 3**).

It should be noted that the absolute increase in the level of combat value of WS obtained as a result of the modernization process is definitely greater than the increase obtained as a result of the modification process.

Assessing WS in the O&M phase in terms of the possibility of modernization, WS can be divided into three basic categories:

1) Modern WS that meets the requirements, not being modernized.
2) WS that meets the requirements to a limited extent, with modernization potential justifying its further operation.
3) Obsolete WS that does not meet the requirements and does not have the modernization potential justifying its further rational operation.

3. LOGISTICS IN MODERNIZZATION OF WEAPON SYSTEMS

The main task of logistics in the operation of WS is to enable its use and maintenance during both peace (training) and war (combat) activity.

The modernization of the weapon type forces changes to the existing logistics subsystem securing the operation of the modernized weapon type.

Key modifications to the logistics subsystem of the modernized type relate to:

4) Possibilities of performing new maintenance services.
5) Ensuring the availability of new spare parts in ongoing and combat operation (repair kits).
6) Acquiring new competences by service personnel.
7) Provide new means of transport (or adapt existing ones) enabling the movement of a modernized type of weaponry.

The design of the logistics subsystem to support the use of the modernized WS should start at the stage of analyzing the possibilities of meeting new needs and transforming them into technical parameters. It should include an analysis of the following areas:

a) operation planning, e.g.

- defining the exploitation plan throughout the system life cycle:
  - what might work badly?
  - who will fix it?
  - where can you fix it?
  - how will it be repaired?
  - when will it be fixed?
- what levels of operation?
- what will the maintaining subsystem structure look like?
- repair or replacement?
- what documents are to be admitted to service (e.g. certificates)?
- ...,

b) determination of the possibilities and manner of recruiting personnel:

- staff structure,
- skills ranges,
- obtaining certificates,
- number of staff,
- ...,

c) supply subsystem design:

- acquisition, storage, movement, allocation and placement of stocks and spare parts,
- inventory control methods,
- standardization of spare parts,
- supply chain length,
- ...,

d) determining the availability and design of maintaining devices:

- type of devices: mobile or permanent located in facilities,
- equipment for material measures,
- general and special tools (measuring instruments, ...),
- device calibration,
- automatic or manual operation of devices,
- ...,

e) creating and planning the use of the database:

- electronic form or paper form?
- data format: in descriptive, tabular form, technical drawings (diagrams), ...,
- data storage method - e.g. on electronic media,
- different data requirements,
- ...,

f) organization of trainings and instructions:

- training programs and techniques,
- training rooms,
- training and training participants: logistics and operators,
- forms of training: individual and group,
- training at all levels of use,
- training means,
- ...,

g) computerization - a logistics subsystem should use computer hardware and software in every sphere of its activity,

h) determining the availability and design of the logistics infrastructure:

- warehouses, workshops, hangars, ...,
- field infrastructure arrangement and equipment, etc.,

i) determination of the possibilities and design of transport equipment:

- containers, pallets, ...,
- loading units,
- protection of transport units,
- equipment requirements (hoists, cranes, forklifts, ...),
- size and weight of resources moved,
- ....

4. CONCLUSION

The commissioning of a new modernized type of armament that meets the new requirements implies the need to adapt the logistics subsystem supporting the use of this type of armament so that the WS based on it is self-sufficient in operation.

The presented design approach of the new logistics subsystem includes the most important aspects of logistics functioning having a direct impact on the self-sufficiency of WS.

The lack of such a systemic approach generates future operational problems of the modernized type of weaponry (which does not ensure its self-sufficiency. A good example illustrating the negative effects of the lack of such an approach is the example of modernization of the Leopard 2A4 tank to the Leopard 2PL version. As a result of the modernization of this tank, its weight increased to about 60 tons. This resulted in that the existing wheeled transport means were not able to transport the modernized tank in accordance with applicable regulations. Therefore, the decision was made (apart from modernization costs) to purchase new sets for the transport of tanks up to 70 tons [8]. The start of delivery of sets (in 2020) coincides with the planned completion of modernization of 128 Leopard 2A4 tanks to the Leopard 2PL standard. Of course, this increases the cost of upgrades that were not previously considered.

When planning the modernization of the WS (and its costs), system planning of the logistics subsystem quantitatively, qualitatively and cost must also be taken into account.

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