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CHALLENGES IN THE MANAGEMENT OF DEFENSE RESOURCES LIFE CYCLE COST ANALYSIS FOR A MILITARY CAPABILITY (High Mobility Artillery Rocket System-HIMARS)

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***Abstract*:**
Life cycle cost (LCC) represents all the costs that will occur during the life of a piece of equipment from the moment it is acquired, the period of time it is operate and maintained and finally its disposal.

The aim of this paper is to present the importance of developing a life cycle cost analysis for a HIMARS BDE, especially since this capability is new in our military. Nevertheless, there must be emphasized the fact that this kind of system has never been used by any Eastern Europe countries, therefore, there is scarce reference regarding the total costs of using it. Another issue that must be addressed upfront in the fact that, since Romania has the latest version we can only speculate the life cycle cost since no system of this kind has been dispose yet.

Key words: HIMARS, LAROM, Life cycle cost, acquisition, defense planning, capability

Life cycle costs of a system consist of all costs to be made by the owner of the system to acquire it, to exploit it in accordance with the performance requirements and to dispose it.

This is a rather generic definition of Life Cycle Cost and does not give a decisive answer whether some cost elements or expenses can be attributed to a system.

Furthermore, throughout the world many different phrases are used to define Life Cycle Costs. Sometimes also different names are used to define the same thing. In this chapter a distinction is made between Life Cycle Cost (LCC), Total Ownership Cost (TCO) and Whole Life cost (WLC) and these are described and clarified in more detail.

If it is clear that direct costs are to be considered when dealing with Life Cycle Cost, several questions are raised when it comes to indirect costs. To help people give harmonized answers, several concepts have been defined that cover an increasing range of costs.

LCC Life Cycle Cost = Direct costs + Indirect Variable costs
TOC Total Ownership Cost = LCC + Linked Indirect Fixed costs
WLC Whole Life Cost = TOC + Non linked Indirect Fixed costs
These definitions are graphically clarified in the figure below.

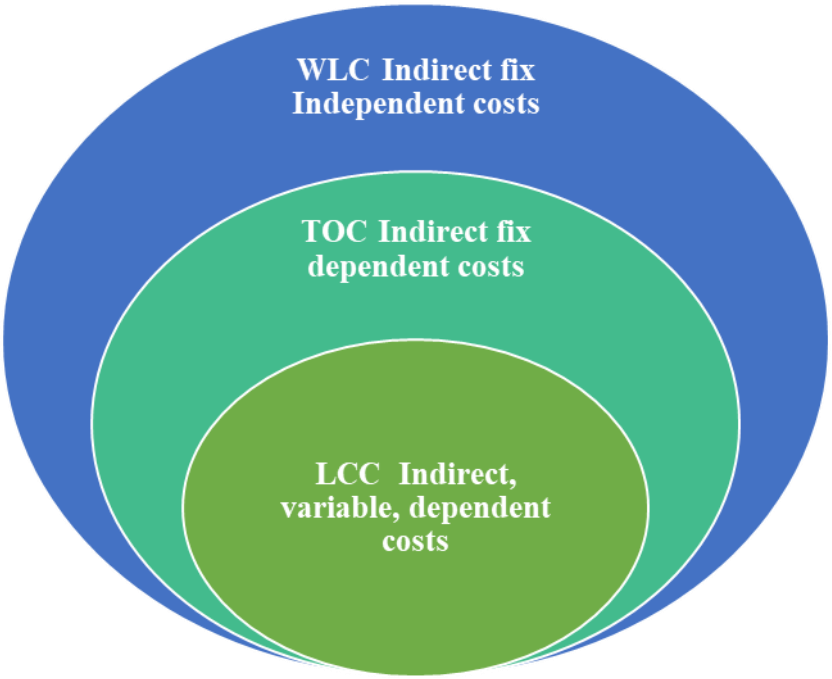


Fig.1 - LCC, TOC AND WLC

There are two main situations in which *life cycle cost* can be a tool for the defense decision makers and planners, namely the economic appraisal and the financial appraisal.

If the economic appraisal is used by an organization (also military) in regards with their overall well-being, the financial appraisal focuses on affordability. Although on a first glance these two sorts of appraisals are seemingly different, nevertheless, they don't exclude each other. Used together they only enable the *life cycle cost* and make it an even more proficient tool in optimizing the total cost of a weapon system offering the defense planners a way to predict and avoid added costs.

Moreover, the *life cycle cost* should be used as a reference mark when you try to squeeze the *best value for money* during a procurement process. It enables the military planners to make sound decisions by offering them an optimization criterion when they are looking for the best option in a capability. Ideally the chosen capability should respond to the security engagements taken to the national defense and also taken to the strategic alliance that you are a part of. More often the variables taken into consideration by the *life cycle cost* when used to make decisions between different options are time, total cost and the overall performance.

There will always be a capability gap which in turn leads to the unwanted readiness gap. When defense planners choose the *life cycle cost* to study the options they have, they must consider closing those gaps and the best way to do it is to procure the assets and their associated technologies at the lowest price. Of course, it would not be a proper approach to buy equipments only in regards to the lowest cost. Moreover, it is not a solution to watch the western countries from the alliance and *import* their approaches. They might not work. In fact, this never works! The planners need a clear strategic vision, and a top to bottom approach that will provide *the big picture* since all the stakeholders are involved. There have always been overlaps and misunderstandings between the personnel involved in the capability acquisition, those paying it and those who operate and maintain it. The *life cycle cost* analysis could and should give every party involved their answer.

So, in this first phase of identifying and filling the capability gaps planners can't yet identify

the detailed costs but offers them a glimpse of the final figures.

After identifying the gaps, the project team should assembly. Once the team is given the requirements they focus on the performance, cost and the necessary time in which a certain capability could reach final operating capability. The entire time the team should adopt an "what if" attitude this way taking into account any possible risk.

Once all options are properly identified and assessed, the third phase takes in, namely the call for the defense industry to compete for the building and supplying of the newly funded capability. Of course, not always the national defense industry is responsive mainly because of its limitations. Regardless of the producers that are engaging in the production process, the evaluation of their bids should be based on *life cycle cost analysis* because there is an understandable need to address both economic and financial aspects.

Also, using this tool helps the defense planners to match the numbers and the laws set by the national Government on defense investments. Also, using *life cycle cost* offers the decision makers the necessary information for the long-term budgeting. At this phase when you present the plans to the decision makers, the military planners should have already identified all the costs.

In case of specific factors like inflation, political changes, priorities changes, security environment, multiple deployments, etc. there is a possibility that additional costs to occur for the already in-service equipment. It is well known the fact that towards the end of the life cycle expenditures for maintenance and operating usually increases. Moreover, because of unexpected situations, delays in the delivery of the new equipment may appear. This forces the commanders to still use the old assets which in turn lead not only to even more costs but to the unfortunate possibility of not being able to integrate that old capability on a joint or multinational level.

In conclusion, it is neither possible nor desirable to gather and disseminate the information at the same level of detail throughout the entire life cycle because there are differences in utilization as years pass by.

When the *life cycle cost* is used, usually there should be two categories of costs taken into consideration:

- past costs which usually refer to the already committed costs which in turn can't be cut or undone without some loss because of the contracts terms;
- future costs which unlike the previous ones can be amended.

Life cycle cost could be used in forecasting the overall cost throughout the life span of a piece of equipment but only if the defense planners have a proper understanding of the costs for the latest acquisitions and the costs for the already in-service equipment.

Collection and dissemination of the costs during a *life cycle* for any particular piece of equipment helps the decision makers and planners to:

- analyze differences between forecasting and actual costs;
- feed costs databases;
- identify cost drivers;
- implement management control.

On the other hand, the data collection depends very much on the costs collecting system and the financial management system. In disseminating and interpreting this collected data there is the possibility of using a common data base within NATO logistic support system but for this it is also necessary to acknowledge the purpose that stays behind using this tool. Therefore, it might be necessary to *translate* this data so that it can be integrated in our way of thinking.

One of the realms in which the *life cycle cost analysis* can be used is the acquisition process.

It is a known fact that in planning activities the first step is with the proper identification of a defense need/ requirement. The next logical step is to implement the most efficient and effective

method to address that need. Once the planners have identified the method, they will initiate a project in response to that need. Along the way the process goes from just a concept to planning phase and finally the development phase. All this process must be performed taking into account the need to meet the requirements, the socio-political environment and none the less the costs.

When implementing a *life cycle* system planners must consider four factors, namely conception, acquisition, in-service and disposal.

When addressing the conception phase, the main focus should be on the vastness of the *life cycle costs*, if the maintenance is feasible and any other risk involved in the selection of that specific option. Even if there is not an enough quantity of data available about a certain weapon system there is still the possibility of estimating costs in realms such as personnel, facilities, logistic support, spare parts, training, training facilities, etc.

Throughout the acquisition phase, *the life cycle cost analysis* enables the defense planners in evaluating the contractor and also in monitoring the factors that ensure the effectiveness.

Regarding the in-service phase, *the life cycle cost analysis* enables the manager of that specific piece of equipment to continuously oversee the system's effectiveness by comparing what was previously estimated with the actual values. This thing if done properly can help identifying possible problems and determine their causes and linked effects.

Finally, during the disposal phase, *the life cycle cost analysis* helps determining the most cost and operational effective alternative in relation to rebuilding or replacing the system. If the decision is to replace the system then the responsible parties must find the cost-effective disposal method. Of course this disposal refers mainly to the non-usable elements.

Another realm in which the *life cycle cost analysis* can be used is the defense planning.

The *life cycle cost* method can assist the planners and project managers in:

- long term defense planning;
- comparison of competing projects;
- comparison of logistic concepts;
- decisions about replacing aging equipment;
- selection between competing contractors.

As a conclusion, every NATO member country should take into consideration this method when deciding to acquire combat capabilities since they imply a great deal of resources involved.

Because of the volatile security environment that NATO had to coup within the last years, a strategic decision has been made, namely the strengthening of the eastern flank of the alliance. Hence, several multinational structures have already been founded on Baltics, Poland, Romania and Bulgaria with the purpose of providing NATO with a swift response to any kind of threat. Among the measures undertaken by the Romanian Government, besides assuming the role of Host Nation Support for different joint structures, it was the raising of the defense budget to 2 % of GDP. This helped the defense planners and the political factor to come up with some major endowment programs for a timeline of 9 years, between 2017 to 2026. One of these programs is the HIMARS Brigade.

Up until now, the Romania's defense most proficient indirect fire capability were the 152 mm howitzers and one LAROM Brigade which had the possibility of engaging targets up to 40 km. This was not enough for the NATO's Eastern flank and, consequently, as a result of NDPP (NATO Defense planning process) that produced the operational requirements for the capability required a choice has been made. HIMARS responded the best to these requirements from the effect on target, battle damage to the high interoperability. Mostly, this operability the system could in any moment be assigned to NRF (NATO Reaction Force).

The acquisition of HIMARS system was established through the Law number 46/ 2018

which enabled the national defense to respond to the NATO and national defense' requirements to realize a strong and integrated indirect fire support capability. The next step for Romanian Government was to sign in February 2018 the *Letter of Offer and Acceptance* after the approval of the US Congress in accordance with the standard procedures. Through this agreement Romania embarked on the procurement of three systems of eighteen launching installations including the ammunition, logistic support, maintenance and the latest version of cryptographic equipment.

The HIMARS system is a state-of-the-art asset, being one of the most viable systems of its kind. Presently, it is mostly used by the US Army and US Marine Corps and it has been successfully used in battle in Iraq, Syria, against ISIS, and in 2018 against the Taliban insurgents in Afghanistan.

The main mission of the newly formed HIMARS Brigade in the Romanian armed forces is to discover attack and destroy the enemy's indirect fire capabilities, air defense concentrations, logistic convoys, personnel carriers and also to support the advancement of friendly forces. Unlike the old LAROM which could engage the targets at maximum 40 km, HIMARS can engage targets up to 300 km. It is capable to open fire in maximum 16 seconds and leave the launching position with a speed of 85 km/ h before the enemy's radar could intercept it.

Nevertheless, as state of the art as it may be, HIMARS implies high costs of acquisition, maintenance, training and operating and most probably high costs regarding the disposal. Considering that it is the latest version of this asset, it is highly difficult to project some *life cycle costs* since none of these systems have terminated their resources.

In the endeavor of coming with some costs for HIMARS *life cycle* several aspects must be taken into account such as: artillery doctrine changing, force reorganization, infrastructure requirements, acquisition, operating and support (fuel, spare parts, other supplies and services), training, target acquisition system and last but not least the disposal. Also, there must be considered the external factors too, such as inflation, increased cost for spare parts production, fuel and lubricants constantly increasing costs and priorities changes on behalf of the political factor.

As stated before, one HIMARS Brigade consists of 3 battalions endowed with 18 launching installations each, that leads to a total of 54 pieces each one of them with its own *Wrecker* (a sort of crane used to load the ammunition packs on the installation) different types of ammunition and other utilitarian gears.

"The Government of Romania has requested the possible sale of fifty-four (54) High Mobility Artillery Rocket Systems (HIMARS) Launchers, eighty-one (81) Guided Multiple Launch Rocket Systems (GMLRS) M31A1 Unitary, eighty-one (81) Guided Multiple Launch Rocket Systems (GMLRS) M30A1 Alternative Warhead, fifty-four (54) Army Tactical Missile Systems (ATACMS) M57 Unitary, twenty-four (24) Advanced Field Artillery Tactical Data Systems (AFATDS), fifteen (15) M1151A1 HMMWVs, Utility, Armoured, and fifteen (15) M1151A1 HMMWVs, Armor Ready 2-Man. Also included with this request are: fifty-four (54) M1084A1P2 HIMARS Resupply Vehicles (RSVs) (5 ton, Medium Tactical Cargo Vehicle with Material Handling Equipment), fifty-four (54) M1095 MTV Cargo Trailer with RSV kit, and ten (10) M1089A1P2 FMTV Wreckers (5 Ton Medium Tactical Vehicle Wrecker with Winch), thirty (30) Low Cost Reduced Range (LCRR) practice rockets, support equipment, communications equipment, sensors, spare and repair parts, test sets, batteries, laptop computers, publications and technical data, facility design, training and training equipment, systems integration support, Quality Assurance Teams and a Technical Assistance Fielding Team, U.S. Government and contractor technical, engineering, and logistics support services, and other related elements of logistics and program

support. The total estimated program cost is $1.25 billion."[1]

Of all the assets comprising the HIMARS capability the most important ones are the launchers and their allocated ammunition. These are the parts that deliver the effect on target. Of the total cost of $1.25 billion the launchers have an approximate cost of $275 million and the prices for the rockets are between $110,000 and $1 million, depending on the type.

"It is not clear exactly how much the rocket system costs today, but the unit price of HIMARS was around $5.1 million in 2014, according to *Military Today*. The figure included the launcher and some ammunition. Lockheed Martin has been contacted for comment. HIMARS carries a single six-pack of GMLRS rockets or one TACMS missile, according to Lockheed Martin. Individual GMLRS rockets cost about $100,000."[2]

"According to the Federation of American Scientists, a single ATACMS round costs approximately $820,000."[3]

On the following pages I will present the calculations made in a very synthetic manner to determine the *Life Cycle Cost* for HIMARS and the costs implied for the maintaining in activity of LAROM System after the 20th year in service.

HIMARS & LAROM COST DATA

COST INFORMATION UNIT	ALTERNATIVES	
	HIMARS $ mil.	LAROM $ mil.
HIMARS Launchers	275	0,00
GMLRS M30A1 (rocket)	8,91	0,00
GMLRS M31A1(rocket)	8,91	0,00
ATACMS (missile)	19,68	0,00
M1089A1P2 FMTV Wreckers	16,22	0,00
AFATDS	2,55	0,00
M1151A1 HMMWVs utility	9,44	0,00
M1151A1 HMMWVs, Armor	16,82	0,00
M1084A1P2 HIMARS RSVs	18,29	0,00
M1095 MTV Cargo Trailer	21,15	0,00
Military construction	21,61	0,00
Training	1,56	1,22
Operating expenses	1,57	76,00
Support equipment	5,41	0,00

[1] https://www.dsca.mil/press-media/major-arms-sales/romania-high-mobility-artillery-rocket-systems-himars-and-related, accessed on Nov the 2nd, 15.54.

[2] https://www.newsweek.com/who-makes-himars-cost-launch-missle-fire-manufacture-1752295, accessed on Nov the 2nd, 16.14.

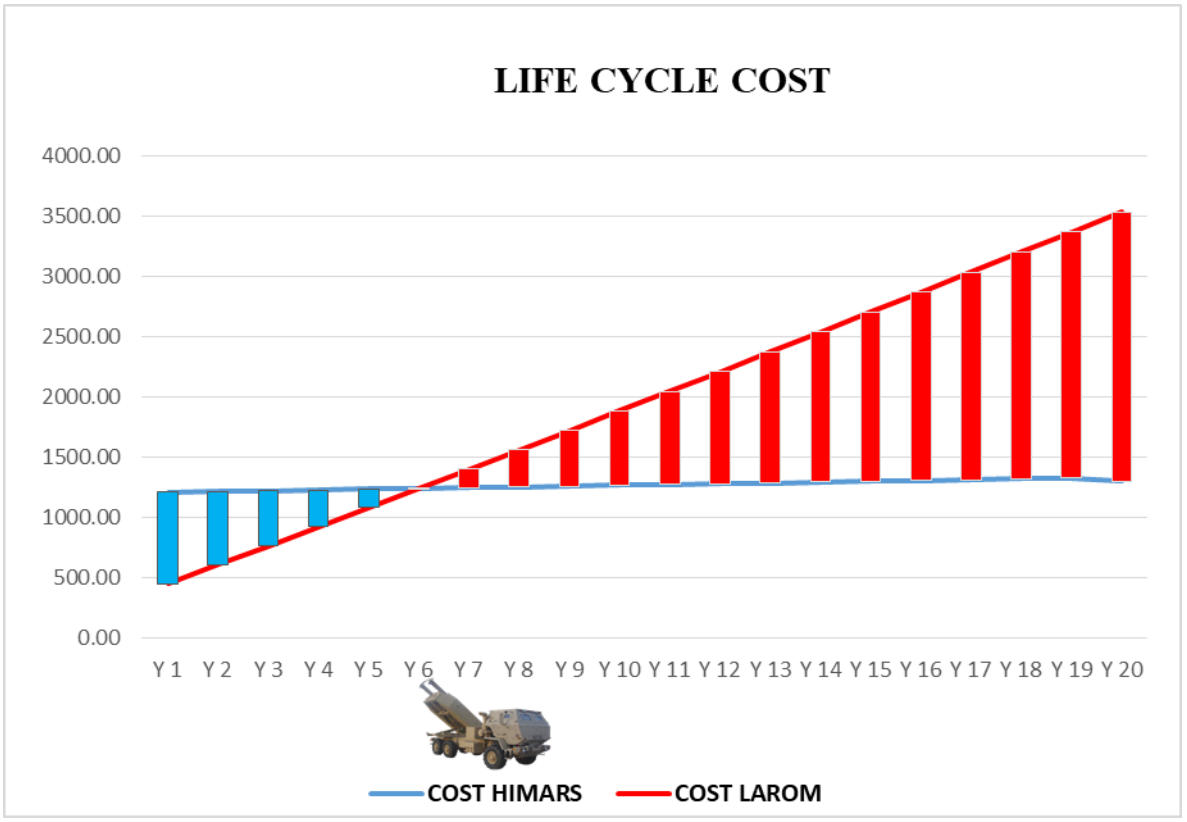
[3] http://www.military-today.com/missiles/atacms.htm, accessed on Nov the 2nd, 16.28.

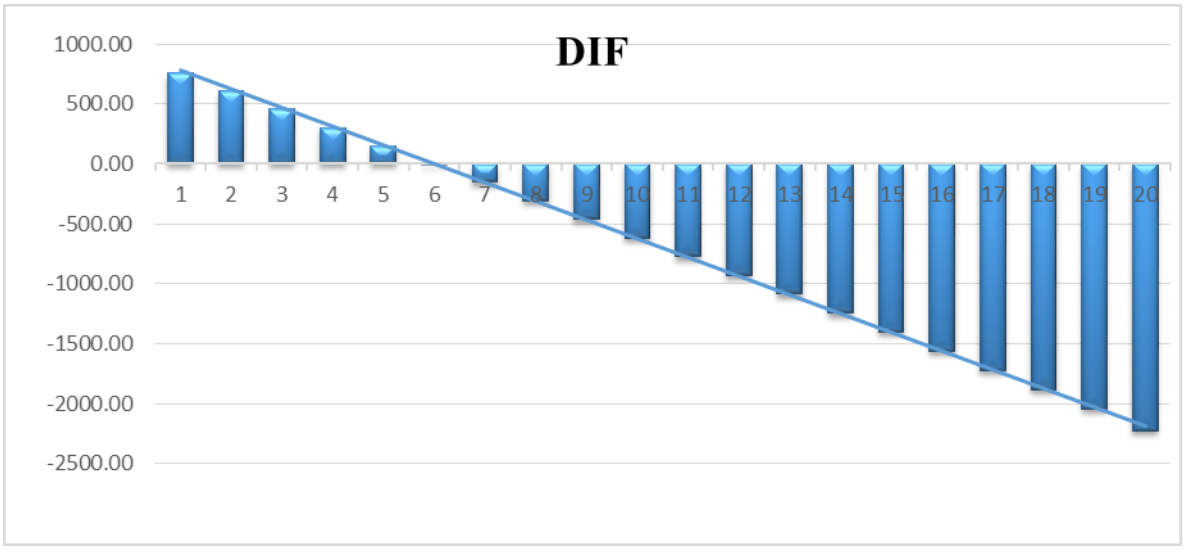
COST INFORMATION UNIT	ALTERNATIVES	
	HIMARS $ mil.	LAROM $ mil.
Communication equipment	6,34	2,50
Sensors (Bayraktar Drones)	150,00	0,00
Laptop computers	18,56	0,00
Training and guiding teams	2,35	0,00
Logistic support service	6,53	0,00
Others (classified)	600,00	374,11
Total cost year 1	1.210,90	453,83
training (+0.3%)	1,56	1,22
maintenance (+0.4%)	1,58	76,30
inflation rate (2%)	3,20	79,08
Total cost year 2	1.217,24	610,44
training (+0.3%)	1,57	1,23
maintenance (+0.4%)	1,58	76,61
inflation rate (2%)	3,21	79,39
Total cost year 3	1.223,61	767,67
training (+0.3%)	1,57	1,23
maintenance (+0.4%)	1,59	76,92
inflation rate (2%)	3,23	79,71
Total cost year 4	1.230,00	925,52
training (+0.3%)	1,58	1,23
maintenance (+0.4%)	1,60	77,22
inflation rate (2%)	3,24	80,03
Total cost year 5	1.236,41	1.084,01
training (+0.3%)	1,58	1,24
maintenance (+0.4%)	1,60	77,53
inflation rate (2%)	3,25	80,35
Total cost year 6	1.242,85	1.243,12
training (+0.3%)	1,59	1,24
maintenance (+0.4%)	1,61	77,84
inflation rate (2%)	3,26	80,67
Total cost year 7	1.249,30	1.402,87
training (+0.3%)	1,59	1,25
maintenance (+0.4%)	1,61	78,15
inflation rate (2%)	3,27	80,99
Total cost year 8	1.255,78	1.563,26
training (+0.3%)	1,60	1,25
maintenance (+0.4%)	1,62	78,47
inflation rate (2%)	3,28	81,31
Total cost year 9	1.262,28	1.724,29

COST INFORMATION UNIT	ALTERNATIVES	
	HIMARS $ mil.	LAROM $ mil.
training (+0.3%)	1,60	1,25
maintenance (+0.4%)	1,63	78,78
inflation rate (2%)	3,29	81,63
Total cost year 10	1.268,81	1.885,96
training (+0.3%)	1,61	1,26
maintenance (+0.4%)	1,63	79,10
inflation rate (2%)	3,31	81,96
Total cost year 11	1.275,36	2.048,27
training (+0.3%)	1,61	1,26
maintenance (+0.4%)	1,64	79,41
inflation rate (2%)	3,32	82,29
Total cost year 12	1.281,93	2.211,23
training (+0.3%)	1,62	1,26
maintenance (+0.4%)	1,65	79,73
inflation rate (2%)	3,33	82,61
Total cost year 13	1.288,52	2.374,83
training (+0.3%)	1,62	1,27
maintenance (+0.4%)	1,65	80,05
inflation rate (2%)	3,34	82,94
Total cost year 14	1.295,14	2.539,09
training (+0.3%)	1,63	1,27
maintenance (+0.4%)	1,66	80,37
inflation rate (2%)	3,35	83,27
Total cost year 15	1.301,78	2.704,01
training (+0.3%)	1,63	1,28
maintenance (+0.4%)	1,67	80,69
inflation rate (2%)	3,36	83,61
Total cost year 16	1.308,44	2.869,58
training (+0.3%)	1,64	1,28
maintenance (+0.4%)	1,67	81,01
inflation rate (2%)	3,38	83,94
Total cost year 17	1.315,13	3.035,81
training (+0.3%)	1,64	1,28
maintenance (+0.4%)	1,68	81,34
inflation rate (2%)	3,39	84,27
Total cost year 18	1.321,84	3.202,70
training (+0.3%)	1,65	1,29
maintenance (+0.4%)	1,69	81,66
inflation rate (2%)	3,40	84,61

COST INFORMATION UNIT	ALTERNATIVES	
	HIMARS $ mil.	LAROM $ mil.
Total cost year 19	1.328,57	3.370,26
training (+0.3%)	1,65	1,29
maintenance (+0.4%)	1,69	81,99
inflation rate (2%)	3,41	84,95
Salvage value	32,23	8,13
Total cost year 20	1.303,10	3.530,36

YEAR	COST HIMARS	YEAR	COST LAROM	DIFFERENCE $ mil.
Y 1	1210,90	Y 20+1	453,83	757,07
Y 2	1217,24	Y 20+2	610,44	606,81
Y 3	1223,61	Y 20+3	767,67	455,95
Y 4	1230,00	Y 20+4	925,52	304,48
Y 5	1236,41	Y 20+5	1084,01	152,41
Y 6	1242,85	Y 20+6	1.243,12	-0,28
Y 7	1249,30	Y 20+7	1402,87	-153,57
Y 8	1255,78	Y 20+9	1563,26	-307,48
Y 9	1262,28	Y 20+10	1724,29	-462,00
Y 10	1268,81	Y 20+11	1885,96	-617,15
Y 11	1275,36	Y 20+12	2048,27	-772,91
Y 12	1281,93	Y 20+13	2211,23	-929,30
Y 13	1288,52	Y 20+14	2374,83	-1086,31
Y 14	1295,14	Y 20+15	2539,09	-1243,96
Y 15	1301,78	Y 20+16	2704,01	-1402,23
Y 16	1308,44	Y 20+17	2869,58	-1561,14
Y 17	1315,13	Y 20+18	3035,81	-1720,68
Y 18	1321,84	Y 20+19	3202,70	-1880,87
Y 19	1328,57	Y 20+20	3370,26	-2041,69
Y 20	1303,10	Y 20+21	3530,36	-2227,26





In this case study I have analyzed the following alternatives: the acquisition of HIMARS or keeping in use the LAROM. In taking this decision I have interpreted the data resulted from the *life cycle analysis* of both capabilities, namely HIMARS and LAROM indirect fire systems. The data resulted ensures the decision makers to decide if the LAROM System should be maintained in activity exceeding the life span of twenty years.

The *life cycle analysis* for the keeping in use the LAROM or procurement of the HIMARS has been done taking into consideration the following factors:

- the necessity of restructuring the infrastructure;

- operating and logistic support;
- initial and follow up training;
- target acquisition system;
- maintenance;
- disposal and/ or salvage.

When calculating the costs for LAROM, I have taken into consideration the necessary costs to maintain in use this system after the 20th year in service. The object of this analysis is to determine if it is necessary the keeping in use of the LAROM system beyond the 20 years cycle or is more opportune to acquire another indirect fire asset, namely HIMARS. The present synthetic analysis is done considering only the technical and tactical characteristics. As a result of this, I have concluded that it is more opportune to replace the LAROM system with HIMARS from the 20+6th year because the operating and maintaining costs for LAROM are significantly greater than the procurement of HIMARS. In 2003, LAROM entered the service which means that in 2023 it should be out of service. Since the LAROM system still has resources for another 6 years, it could accomplish the operational and tactical requirements at division level. As a result of this, the two Romanian Artillery Regiments have already received the order to perform a personnel reorganization so that beginning with March 2023 they would be able to operate the LAROM system.

To sum up the case study, the following conclusions could be drowned:

- beginning with the 20+6th year of use for LAROM, this system must be replaced because of the increasing *Life Cycle Cost*;
- considering NATO requirements regarding the defense of its Eastern flank, namely to be able to engage targets at maximum range of 300 km, NLT March 2023, corroborated with the readiness level required for the single Artillery Brigade in the country (The 8th HIMARS BDE), the best solution for a new indirect fire capability is HIMARS;
- for a better use of the LAROM's remaining life resources, this system will be integrated for the next 6 years to division level being assigned to the Artillery Regiments.

Another thing that must be considered regarding the possibility of using the HIMARS capability at its full potential is the acquisition of a new Target Acquisition System which could be integrated within HIMARS Command Post. A Target Acquisition System, or in short TAS, is a multi-use system which is used for identification, location and detection of the target to permit the effective employment of lethal and non-lethal weapons. The acquisition contract for HIMARS did not include a TAS. Consequently, the Romanian Government should find an offer for this system as soon as possible. HIMARS is a capability which can engage targets at strategic and operative level but because of the limitations of the current TAS it can only engage targets at tactical level. The HIMARS system has a range of 300 km and the current in-use TAS (ARGUS) has a range of only 24 km. The most compatible alternatives that the planners have are AN/ TPQ-53 Counter Fire Acquisition Radar System and Bayraktar TB2 Drone. Each one of them has advantages and disadvantages but regardless the choice there will be extra costs for the capability.

Considering that a choice for a TAS hasn't been made yet, my paper focuses mainly on the target engagement part of the capability which is the HIMARS system itself. Nevertheless, for this endowment program there will be additional costs up to another $120 million, necessary for the Target Acquisition System's acquisition, personnel training, operating & maintenance and the integration with the HIMARS.

Conclusions

Life cycle cost is the most proper method to be used when you analyze multiple options that you have when trying to procure new assets or capabilities.

The first important advantage in using this method is that it enables the defense planners with the possibility of examining all the costs are being supported by the beneficiary and to determine if these costs could be lowered by using more advanced technology and more proficient maintenance methods.

Another benefit in using the *life cycle cost* method, as concluded from the presented case study, is the possibility to determine the benefits that may be realized if you replace the obsolete weapon systems with new ones, designed to deliver a higher effect on targets with fewer support requirements. Also, it helps projecting a future use for the remaining life resource for the replaced systems.

Also, *life cycle cost* helps the decision makers clearly define the procured system's functional, technical and tactical expectations, which are understood and agreed to by all stakeholders. Moreover, it enables everybody involved to foresee in a consistent manner the future problems that they might encounter. Hence, they will have fewer surprises.

In essence, *the life cycle cost* approach provides the planner or life cycle manager with the tools required to make sound, rational decisions to determine which of the possible alternatives he has is the most cost effective one.

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