Application of economic analysis in audit efficiency of investments in the modernization of weapons

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Abstract

The article examines one of the typical problems for the practice of internal auditors of the Defense Ministry of Ukraine, which is related to the need to increase the reliability and provability of audit conclusions of the financial and material resources management system, using the example of checking the expediency of realization investment projects.

To solve the mentioned problem, a methodology is proposed based on the involvement of military-economic analysis approaches to audit procedures by conducting a comparative juxtaposition of the ratio of costs for the modernization of a sample of weapons and benefits from its implementation and probability indicators of the effectiveness of the use of a sample of weapons before and after its modernization.

For the practical use of the proposed methodology, an example is given for a specific sample of weapons with a detailed review of the procedures of the methodology and substantiation of the selected chosen conditions and the obtained results.

In order to analyze the results of the audit and make a final decision in the relevant authority, it is proposed to compile the calculations into a summary table, convenient for users of the audit report.

It is noted that the proposed method of evaluating the effectiveness of investments in the modernization of weapons can be extended to a wide range of military equipment with the appropriate correction of conditions and technical and economic indicators.

Key words: economy, analysis, audit, efficiency, investment, armament.

Introduction

Today, the activities of the internal auditors of the Ministry of Defense of Ukraine are aimed at improving the management system of financial and material resources, preventing facts of illegal, inefficient and ineffective use of resources, as well as the occurrence of errors or other shortcomings in the activities of the Ministry, the General Staff of the Armed Forces of Ukraine, and other organizational structures in system of the Defense Ministry.

The introduction of a system of defense management and defense resources management based on the experience of NATO member states envisages the use by internal auditors of effective methods of evaluation of the functional processes of the Ministry of Defense and the Armed Forces.

At the same time, audit procedures are used to form an assessment of the effectiveness and efficiency of defense resource management, among which a special place belongs to analysis as a tool for proving evidentiality of an audit conclusion.

Literature Review and Theoretical Framework

The following scientists made a significant contribution to the development of the theory and practice of internal control and internal audit: S.V. Bardash, O.O. Doroshenko, T.O. Kamenska, M.D. Korinko, M.S. Pushkar, V.Z Semanyuk and other.

The issue of theoretical and methodological tasks of analysis, including in audit, was studied by economists: K.V. Izmailova, M.Ya. Korobov, L.A. Lakhtionova, M.R. Luchko, V.O. Mets, O. AND. V. Pavlovska, A.M. Poddyerogin, V.V. Sopko, V.M. Sutormina, O.O. Tereshchenko, T.E. Unkovska, A.V. Chupis, S.I. Shkaraban, M.I. Yatskiv et al. However, questions remain that require further researches.

Task statement. At the beginning of the full-scale invasion of the Russian Federation into Ukraine, the Armed Forces of Ukraine used morally and physically outdated samples of weapons that did not provide the necessary effect on the battlefield. This led to significant human, material and financial losses. With technical support of partner countries, the need for modernization of obsolete equipment is gradually decreasing, due to the decrease in its number due to combat losses. In the course of hostilities, only according to documented data, Ukraine received almost 400 tanks, 700 units of armored vehicles and 170 artillery systems as trophies (The largest suppliers).

Our foreign partners provide significant assistance to the Ukrainian Armed Forces. Yes, the United States alone has already given Ukraine $21.5 billion in military aid since the start of the full-scale war on February 24, 2022. As reported by the US State Department, the aid includes: 142 towed 155-mm M777A2 howitzers, 36 105-mm howitzers and 38 HIMARS multiple-launch rocket systems and 20 120-mm mortars (The US State Department).

Despite the technical support of partner countries, the need for modernization of equipment does not decrease. Therefore, there is an urgent question of determining the expediency of modernization of outdated weapon, both their own and trophy ones, taking into account the risks and benefits of such investment projects.

In order to solve this issue, it is proposed to develop a toolkit that can be used by the internal audit when evaluating the specified investment projects.

The purpose of the article. On the basis of economic analysis approaches, propose a methodology for evaluating the effectiveness of investments in the modernization of weapons with the definition of criteria and performance indicators, intended for use in the activities of internal auditors of the Ministry of Defense of Ukraine.

Data and methods

To achieve the goal of the research, the methods of comparative analysis, discounting, determining the probability of achieving the goal after repeated actions, and project analysis were used. The methodology is developed on the example of a specific type of weapon, but can be extended to other types of weapons and military equipment.

Results and Discussion

Even experts are impressed by the success of Ukraine's use of modern high-tech examples of military technology provided by partner countries on the battlefield. Suspicions raised in the U.S. Congress that Ukraine is using military aid for non-purpose are refuted by the Pentagon officials and the results of the war (The United States).

During the visit of the President of Ukraine to the USA at the end of December 2022, the majority of the political elite of the USA supported the aid package in the amount of 45 billion USD,

but several representatives of the Republican Party demanded from Ukraine stricter control over the use of military aid and conducting an audit (Trumpists' proposal).

Russia has lost on the territory of Ukraine the main quantity of modern and modernized equipment and continues to fight morally and physically obsolete samples of weapons and military equipment (further by text – WMT).

Due to the increase in the number of trophies equipment, there is a legitimate question of the expediency of modernization of Soviet-made WMTs located on the Armed Forces of Ukraine and trophy Russian WMTs.

Russians' missiles defense reaches of the goal for the entire depth of our country and has led to destruction of defense industry enterprises, raising risks in times for other enterprises to be destroyed. Therefore, decisions were made to establish bases for repair of heavy equipment in the EU, in particular in Slovakia [6], which has experience of modernization of T-55, which were transferred for needs of the Armed Forces of Ukraine.

In Ukraine, the skilled workers of the defense industry are almost uninvolved and attracted the attention of Western companies, which are experiencing a significant shortage of human capital. The Czech Republic was one of the first to respond to the situation in Ukraine and reached agreements on the relocation of qualified workers to the Czech defense industry. So only Tatra needs 500 employees. The Ministers of Defense of Ukraine and the Czech Republic Alexei Reznikov and Jan Chornokhova announced more than 50 joint projects in the field of defense (To increase the production).

For Ukraine, the possibility is being built, using its own technologies, experience of modernization of Ukrainian and Soviet equipment and technical capabilities of the EU countries, to create joint enterprises for repair and modernization of such examples of WMTs.

Under these conditions, the internal audit system should have modern tools for analyzing the effectiveness (feasibility) of investments in the modernization of such examples of WMTs in order to determine the feasibility of such measures based on the performance of combat efficiency and potential advantage over the opponent.

Consider the problem of increasing the effectiveness of the funds allocated for strengthening the military potential of the Armed Forces, the decision of which on a scientific basis provides its solution, applying methods of quantitative analysis of substantiation of decisions.

Ensuring the Armed Forces' combat capability is not only a military task, but also an economic one, because it is accompanied by significant expenditures of material, labor and financial resources.

The level of combat readiness depends both on the amount of resources allocated for defense and on the effectiveness of their use. As a result of limited resources, the results of the operation of all structural elements of the Armed Forces are largely determined by the efficient use of resources, and as a result, the role of military and economic analysis is increased as a tool of ensuring practical activity of heads of all levels by metods of quantitative analysis and substantiation of decisions.

An internal audit system plays an important role in effective management of financial and material resources. Effective and rational use of the allocated financial (material) resource aimed at the development and establishment of modern armed forces is impossible without introduction in the Ministry of Defense of Ukraine of an established and effective function of internal audit.

In order to obtain a positive auditor's report on the appropriateness of capital expenditures for a certain object, aimed at increasing the defense capacity, it is necessary to determine the effectiveness of this project, using the methodology of military-economic analysis, which provides for consideration of both economic and military components of activity.

The military aspect determines the purpose of the event and depends on the need to strengthen preparedness at a specific time, the economic aspect provides an estimate of the costs and time for the project. Therefore, in the process of military-economic analysis three indicators are jointly considered – the effect, costs and time, which are military-economic indicators and assess the effectiveness of the event.

The effectiveness of funds allocation for a particular project can be assessed by comparison of benefits of its implementation with the costs for the entire life cycle. For this purpose, the general accepted dynamic criteria for the evaluation of project decisions, which provide for taking into account changes in the cost of money in time by bringing various cash flows to a single equivalent by means of their discount and alternative cost of resources. Such an approach allows to accurately trace the movement of cash flows connected with the project.

The coefficient of discount for the years of life cycle is determined by the formula:

$$d_t = \frac{1}{(1+r)^t}$$

where d_t – discount multiplier;
t – is the year of the life cycle of the project;
r – is a discount rate that takes into account the profitability of alternative investment project, inflation and the risk of non-return of money.

A comprehensive assessment of the financial value of the project at the pre-investment stage is carried out by the following indicators:

- net present value of the project;
- benefit/cost ratio (efficiency index);
- discounted payback period (DPP);
- internal rate of return.

Net Present Value (NPV) is the discounted value of the benefits of a project, reduced by the discounted value of the costs over the entire life cycle, or the excess of benefits over costs, reduced to the same conditions of their valuation.

$$\text{NPV} = \sum_{i}^{n} \frac{B_i - C_i}{(1+r)^i},$$

where B_i – benefits of the *i*-th year;
C_i – total costs of the *i*-th year;
n – project implementation period.

According to this criteria, projects with a positive NPV value are preferred.

The ratio (efficiency index) (BCR) shows the efficiency of each monetary unit investment regardless of the amount of total investment and is determined by the ratio of discounted benefits to discounted costs.

$$\frac{B}{C} = \frac{\sum_i \frac{B_i}{(1+r)^i}}{\sum_i \frac{C_i}{(1+r)^i}}.$$

By this indicator, projects are selected for which $\frac{B}{C} > 1$.

Discounted payback period (DPP) – the period of time over which the costs will be repaid by a flow of discounted net benefits.

According to this criterion, projects with the shortest payback period or those that fit within the maximum allowable payback period are accepted.

The internal rate of return (IRR) – is the discount rate that equates the present value of benefits to the present value of costs of a project, i.e. the net present value of the project to 0.

The definition of IRR estimates the break-even point of the project at the discount rate. To find the IRR value, solve the following equation for r:

$$\sum_{i=1}^{n} \frac{B_i - C_i}{(i+r)^t} = 0$$

The determined value corresponds to the internal rate of return (IRR = r).

The possibility of applying military-economic analysis is illustrated by the following example.

According to the experience of combat operations, to perform a fire mission with a sample of weapons, the probability of hitting the target with one shot is P1 = 0.096, it is necessary to release 23 shells to achieve a guarantee of hitting the target Pp = 0.9. Let's define the number of shots (a set of shells) before modernization by n_b^0, after – by n_b^1, then:

$$n_б^0 = \frac{ln(1-P_n)}{ln(1-P_1)} = \frac{ln(1-0{,}9)}{ln(1-0{,}096)} = 22{,}8 \approx 23.$$

We calculate the required set of ammunition n_b^1 after modernization with a guarantee of target destruction Pp = 0.9, using the apparatus of probability theory, by the formula:

$$n_б^1 = \frac{ln(1-P_n)}{ln(1-P_1)} = \frac{ln(1-0{,}9)}{ln(1-0{,}11)} = 19{,}76 \approx 20.$$

Thus, the saving of ammunition after repair with modernization for the performance of one fire mission is 3 units. Determining the number of firing tasks per year (in peacetime and wartime, the number of firing tasks per unit of equipment will differ on average, taking into account, among other things, combat losses), we will get the annual savings of ammunition per unit of equipment.

Taking into account the significant cost of ammunition, the saving of 3 ammunition for each firing task in monetary form is 45000·3=135 000 UAH. According to the data, the modernization is carried out during the overhaul, so the total cost of the modernization will be equal to the amount of costs for these purposes, that is 2100000 UAH. Comparing them with the savings due to the reduction of shells consumption, we see that after 16 firing tasks (2100000:135000= 15.55) the capital costs for modernization will be returned.

At the micro level, a financial analysis of the investment project is carried out. It is crucial to understand all the benefits and costs associated with its realization.

To determine these indicators, specialists are involved who are well aware of the purpose of the project and the expected results and are able to prioritize them for the duration of the project. It is also important to have reliable information for further calculations.

For instance, the benefits can be calculated through the difference between the cost of spent shells and the cost of destroyed enemy equipment (materiel), or through reducing the depreciation of barrels and the number of shells due to the increase in the accuracy of weapons; if the project is aimed at increasing the range of weapons, the benefits can be expressed in the increase in the number of enemy targets and the reduction of our costs due to the increase in the distance of our forces, etc.

Project costs are divided into capital and current (operating) costs. According to the Instruction on the application of the economic classification of budget expenditures, capital

expenditures – are expenditures that are directed to the acquisition of fixed capital, non-current assets, capital investments, capital repairs, etc.

Current expenditures – are expenditures that are directed to the execution of budget programs and ensure the current functioning of budgetary institutions, research, development, activities and provision of current transfers to the population and enterprises (institutions, organizations).

For WMT, operational expenditures will include salaries of military personnel with payroll charges, maintenance and current repair of equipment.

As the barrel service life is 6000 shots, and the ammunition supply after modernization for one task is 20 units, it is possible to perform 6000 tasks per year: 20 = 300 fire tasks. That is, the annual savings of ammunition is 300 · 3 = 900 units. Multiplying this result by the cost of one ammunition, we will get the benefits of ammunition savings in monetary terms for the first year of operation: 45000 · 900 = 40500000 UAH. Depending on the WMT, further benefits can be projected at the same level or corrected by experts.

Previous calculations have shown that with such a proportion of the cost of modernization and the cost of ammunition, the project will pay off after 16 fire tasks, which can happen depending on the intensity of hostilities in the first year of exploitation of modernized equipment. To estimate the cash flows of the project, we will form the initial data on the condition that in a year this sample will exhaust the resource of shots and will require annual overhaul. Limiting ourselves to two years of intensive use of equipment related to combat operations, we will obtain the following initial data (Table 1).

Table 1 – Initial data, UAH

№ year	Nominal cash flows of costs		Flow of nominal benefits
	Capital investments *	Operating costs	
0	2100000	-	-
1	1000000	100000	40500000
2	1000000	100000	40500000
Total	4100000	200000	81000000

*Note that capital investment means the cost of annual repairs, provided that the first repair is carried out in addition to repair and modernization.

Nominal net benefits are the difference between total benefits and costs, i.e. 81 000 000 – 4 100 000 – 200 000 = 76 700 000 UAH.

Calculation of modernization efficiency indicators is presented in Table 2.

To bring different time cash flows to the present time discounting is used. In this case, the discount rate is determined by experts; taking into account the high level of inflation, the calculations are carried out at a discount rate of r = 0.3 (30% loss of value of money per year).

Discounted cash flows are estimated by multiplying the nominal cash flows of costs and benefits given in the condition by the discount factor determined by the above formula.

Net benefits – are the difference between discounted benefits and discounted costs.

The sum of discounted net benefits over the entire life cycle is the net present value of the project NPV (NET PRESENT VALUE), a positive value of which indicates the feasibility of the project.

Cumulative net benefits – are net benefits on an accrual basis. The moment when the cash flow changes from minus to plus indicates the beginning of the payback of investments.

The benefit-cost ratio – the ratio of the total discounted benefits divided by the total discounted costs over the entire life cycle – shows how much benefit in monetary value falls on 1 monetary unit of costs. The value of this indicator, greater than one, indicates the feasibility of the project.

The internal rate of return was not calculated, since for such benefit-cost ratios any acceptable discount rate will give a positive result.

Table 2 – Calculation of the efficiency of investment in the modernization of a weapon sample

№ year	Nominal cash flows of costs, UAH thousand	Flow of nominal benefits, UAH thousand	Discount coefficient at 30% rate	Discounted cash flows			Cumulative net benefits, UAH thousand
				Benefits, UAH thousand	Costs, UAH thousand	Net Benefits, UAH thousand	
0	2100,0	-	1	-	2100,0	-2100,0	-2100,0
1	1100,0	40500,0	0,7692	31152,6	846,1	30306,5	28206,5
2	1100,0	40500,0	0,5917	23963,9	650,9	23313,0	51519,5
Total	4300,0	81000	X	55116,5	3597,0	51519,5	

The obtained results (Table 2) indicate the feasibility of the implementation of the project under consideration, since its net present value is a positive sum and amounts to 51519, 5 thousand UAH, the ratio of benefits and costs is B / C = 55116.5 / 3597.0 = 15.3, that is, the benefits are more than fifteen times higher than the costs, and the project will pay off in the first year of exploitation.

Even if we assume that 50 million UAH was spent on the development of modernization per unit of equipment, the project still remains profitable NPV = 1519.5 thousand UAH, and the ratio B / C = 55116.5/53597.0 = 1.03 > 1, but will pay off in the second year of exploitation.

The above approach shows the expediency of such calculations when justifying the need to allocate funds for the improvement of military equipment, as they clearly demonstrate the flow of funds for the entire life cycle of weapons and military equipment, are available for implementation on conventional computers and are understandable to specialists. Today, no business plan can do without defining such indicators.

Conclusions

The proposed method for assessing the effectiveness of investments in the modernization of weapons and military equipment can be used in the audit of such projects and will be useful in the case of further development and scaling of the military conflict in Ukraine and the growing role of modernization of weapons and military equipment as a update tool the weapons stock for the Armed Forces of Ukraine. Modernization may be relevant both in the short and medium term in the war with the Russian Federation, taking into account a significant number of samples of weapons and military equipment of previous years of production both in the Armed Forces of Ukraine and trophy acquisition.

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