Methodical approach to evaluation of economic efficiency of repairing the weapons and military equipment

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Abstract

The analysis of using the military units and formation during conduct of hostilities on the territory of Donetsk and Luhansk region allows to claim that the one of the main aspect that impact on the success in the execution of tasks are existence of workable samples of weapons and military equipment. Thus, the one of the main source of entering of workable samples of weapons and military equipment in military units (military formations) during conduct of hostilities is returning them from stationary and movable damage-control military formations (units) after the completion of their restoration. Accordingly, during the restoration of damaged samples of weapons and military equipment etc. that need to be purchased from manufacturers, which has resulted to financial and economic costs.

Therefore, in this work are proposed the methodical approach to evaluation of economic efficiency of repairing samples of weapons and military equipment. This approach includes two ways: financial and economic costs on the repairing of weapons and military equipment in the stationary conditionals and in the moving repair and reconstruction military formations (units). The main costs will be focused on the principal salary of repairmen, the basic materials, replacement parts, overhead of mechanical department, common overhead, new product development costs, and special costs during the repairing of weapons and military equipment in stationary conditions. And the basic spending will be focused on the purchasing of new details, assemblages, aggregates, depreciation cost of equipment, the cost of maintaining the personnel of repair specialists, average cost of operational set during the repairing of weapons and military equipment in the moving repair and reconstruction military formations (units).

Keywords: weapons and military equipment, repair, financial and economic costs, stationary and movable repair and reconstruction military units.

Introduction

The experience of execution the tasks in the operation of the combined forces (OCF) (in the anti-terrorist operation(ATO)) on the territory of Donetsk and Luhansk region confirms the wide using of illegal armed groups (IAG), mine and explosive means of destruction that can hit not just a bottom part of armoured combat vehicle (ACV)but also aft parts and lateral projections of samples of weapons and military equipment (WME). Occupation forces and pro-Russian terrorist groups are actively using attacks on OCF units with the help of improvised explosive devices and mines traps, in result there are a lot of significant casualties among personnel and equipment.

Most often, illegal armed groups use antipersonnel, anti-tank, anti-vehicle mines, cumulative as well as concentrated charges of explosives that were adopted by the Soviet Army during the Soviet Union times [1].

The nature of the damage to WME samples during the operation of the combined forces

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(ATO) indicates that the most vulnerable elements of the ACV were the undercarriage, the bottom of the corps, the lateral projection of ACV, and so on. Among the kinetic means of defeat, the most commonly armored combat vehicles were struck by artillery ammunition, mortar shells, and anti-tank grenade launchers [2].

The analysis of losses that were in the military formations attracted to the execution the tasks in the operation of the combined forces (ATO) shows that from the explosion on explosive devices and from kinetic means of destruction in the last years, a significant number of ACV which received damage needed to be restored and returned to units [3].

Accordingly, stationary repair enterprises

Analysis of recent research and publications

A number of works have been devoted to research into the cost-effectiveness assessment of the repair of WME samples that have failed because of combat damage and due to operational reasons, in work [4] proposed scientific and methodological approaches to the study of military-technical and technical-economic aspects of the life cycle of samples of WME. In work [5] the main approaches to the organization of budgetary and defense planning in the Ministry of Defense of Ukraine and the Armed Forces of Ukraine on the development of WME are considered and recommendations are made for the formation of technical and economic indicators of the life cycle of the WME. So, in work [6] addressed the issue of evaluation of technical and economic effectivity of upgrading WME samples, specifying that upgrading extends the life of a sample of weapons, but each sample design has limitations on upgrading in terms of economic feasibility, and in work [7] the economic effect of the introduction of an improved system of maintenance and repair for tracked machines, which are in continuous operation and for machines removed from storage, is determined. In work [8] on the basis of the analysis of the use of armored specialized vehicles and requirements for security there was suggested a methodical approach to the choice of methods for welding (bases) and mobile repair and reconstruction military formations (units) of different levels of hierarchy were involved the in the reconstruction of the WME samples, which received combat damage of varying complexity. That is, the main source of replenishment of the units and military formations that were performing the tasks for purpose was the restoration of WME samples, which suffered combat damage or failed due to operational reasons. Accordingly, for their restoration were expended replacement parts, assemblages, aggregates, components equipment etc., which had to be purchased from manufacturers. All of that is closely connected with financial costs which confirms the actuality of this research.

corps of armored vehicles, which allows to determine the technological cost of performing welding with the help of existing and proposed and in works [9-10] technologies, were determined that for ensure efficient use of financial resources when substantiating the cost indicators of state arms program measures, it is necessary to take a holistic approach, which is in accounting for budgetary funds for the implementation of life cycle stages of the sample WME and also the effect of its use in military formation. In work [11] provides examples of the use of public-private partnership contract models with scheme of the payment the service of contractor based on the normative indicators of the end result of after-sales service of technics. In the literature sources [12] a method based on two criteria for evaluating the reliability of a vehicle is proposed. The first criterion has a technical character and the other has an economic character. The economic criteria consist in evaluation of spending on technical service which are closely connected with the level of reliability of vehicles and usually represents a significant portion of the total cost of each vehicle and in the work [13] a methodology that includes the indicators of serviceability of the WME samples as well as indicators for evaluation the cost of their exploitation is proposed. In the work [14]

approaches of rationalization of logistical expenses for providing distribution according to the ways of their obtaining are presented, and in the work [15] organizational and technical conditionals are given that are connected with the introduction of a system of expedient repair of weapons and military equipment and the issues of unification and adjustment of equipment in the design and production process.

Setting objectives. Thus, counting the difficulties of damage which were taken by the samples of WME in the operation of the

Results and discussion

The repair of WME samples is conducted in stationary or field conditions. Stationary repair units and movable repair and reconstruction military formations (units) of tactical, operational and strategic levels are established for this purpose.

Repair shops of arsenals, central bases and warehouses, intended for repair of WME and assembly units of aggregates, etc. are included to the stationary repair units. Accordingly, the repair and restoration military formations of the strategy and operative levels as well as the repair and restoration units of the military formations are included to the movable one [16].

The financial and economic spending on repairing the samples of WME in stationary repair units can be grouped for such elements:

basic salary of repairmen;

the main materials;

replacement parts;

overhead of mechanical department;

common overhead;

new product development costs and special costs.

The basic salaries of repairmen at the stationary repair units (repair departments of bases, arsenals, etc.) include payments for work carried out directly from the repair of WME [17].

The basic salary P_0 of repairmen tentatively can be calculated by a formula:

$$P_0 = S_1 K_{at} R F_{wtf}$$

where S – hourly rate of the first category, UAH / hour;

WME, which can be repaired with the help of stationary and movable repair and restoration units on the different levels of the hierarchy that will be the goal of this article. This methodological approach will allow to estimate to what repair unit to send the damaged sample of WME depending on the degree of damage received and economic costs for its repair.

combined forces (ATO) it is necessary to make a

methodological approach to evaluation of

economic efficiency of repairing samples of

 K_{at} – average tariffical coefficient of repairmen;

R – number of repairmen, people.;

 $F_{\rm wff}$ – annual valid working time fund of one worker, man-hours.

Extra pay includes vacation pay, night work supplements, overtime hours, and more.

The additional salaries of repairmen, the basic and additional salaries of the auxiliary workers engaged in production maintenance are related to overhead.

The main materials are the materials that are used directly for a repaired WME sample and increased its weight. Main materials are usually steel, non-ferrous metals, electrodes, paints, and the like.

Auxiliary materials include materials that are used in the repair process, but do not remain on them after repair (kerosene, solvent, materials for wiping, etc.).

The annual need for basic materials is determined by the number of samples of WME that are repaired at the established rates of material consumption. The cost of basic materials is accepted at the prices of the supply organizations with the calculation of transport costs.

Auxiliary materials are not included in this article. They are counted in the spending associated with production-related services. If waste is not used in the consumption of basic materials, then the cost of the waste should be excluded from the cost of the basic materials. Replacement parts typically include:

the cost of purchased replacement parts, normals, assemblages, aggregates, accessories and other products that go into completing the products that are in repair;

the cost of suitable replacement parts obtained from the dismantling of the decommissioned repair fund;

the cost of replacement parts remaining after the upgrade of the WME samples, which came from the industrial plants without payment.

The cost of spare parts is determined by the provided services Costs for production and management is a significant part of the cost. These costs are divided into department and general expenses and are related to overhead.

Department overheads include:

energy costs (compressed air, water, power, etc.);

salaries of auxiliary workers, junior servants, accounting staff, engineering staff;

maintenance of buildings and structures (costs for lighting electricity, steam and water for heating and domestic needs);

retention of equipment;

the costs for auxiliary materials;

depreciation;

additional wages of specialist workers;

expenditures on labor protection, innovative implementations, invention.

Department overhead is approximately 180 ... 200% of the basic wages of specialist workers.

Total overhead includes the same cost groups as the department, but on a scale of repair units of bases, arsenals, and more. These include the cost of maintaining a boiler room, compressor, power substations, office buildings, canteen, club, garage, salaries of management staff, postal and telegraph costs, the acquisition of literature and more.

The total overhead costs are about 60 ... 80% of the basic salary of specialist workers.

Costs for the development of production of new products include the costs of technical, documentary and material preparation of production, as well as other costs associated with the development of repair of new types of products.

Special costs include business trip expenses, issuance of bonuses for employees for the development and implementation of new equipment, payment of fines, penalties, etc. [18].

The cost of repairing WME is largely dominated by the cost of purchasing spare parts. Therefore, the main reserve for reducing the cost of repairing the WME is primarily the extension of the nomenclature of parts to be repaired without reducing their quality and reliability, as well as a comprehensive increase in productivity.

The economic value of reducing the cost of production is great and is the most important condition for increasing economic efficiency, achieving the highest results at the lowest labor costs.

The calculation of the cost reduction of products is usually performed on two indicators:

reduction in the cost of commodity products, which is compared to the percentage of the previous year, if the comparable types of products outweigh the overall output;

at the costs on the one monetary unit of commodity products, if the total output of products is dominated by products not compared with the previous year.

Tasks to reduce the cost of commodity products as a percentage of the previous year are developed in terms of improving production efficiency. In this case, the proportion of the compared products in the cost depends on the annual output of products that provided for the planned year.

The decrease in the cost of production is determined by the average annual cost of these products for the previous year.

To determine the planned decline in the cost of production relative to last year, the comparative products that are scheduled for release are estimated by two parameters: the cost in the planned year and its average annual cost over the past year.

When deciding on issues related to lower production costs, higher profits and profitability of production, it is necessary to distinguish between the sales revenue for the plan and the balance sheet profit.

Revenue from the sale of products under the plan is defined as the difference between the amount received from the sale of products at current wholesale prices under the plan, and the cost of sales according to the plan, ie

$$P_r = B_{sp} \quad C_p$$

where B_{sp} – the amount received from the sale of products at the current wholesale prices under the plan, UAH.;

 C_p – cost of products sold according to plan, UAH.

Balance sheet profit is the sum that consists of the profits from the sale of products under the plan and the balance of profits and losses on the balance loan, housing and communal services, etc. Balance sheet profit P_b also includes bonuses for engineering workers

$$P_b = P_r + C_{pb}$$

where C_{pb} – the balance of profits and losses on the balance loan, housing and communal services, etc., or non-operating profit.

Obtained by the repair unit of bases, arsenals, etc., the profit characterizes the final financial result of the team of repairmen, therefore, largely determines its contribution to net income, which is directed to expanding material reproduction, improving working conditions, strengthening the country's defense capability.

But the absolute magnitude of profit does not allow us to still objectively evaluate the performance of the repair unit of bases, arsenals, etc., because increasing its mass can be achieved not only by mobilizing internal reserves, reducing production costs, improving productivity and better use of production funds, but also by the excessive accumulation of the latter through unjustifiably large capital investments, that is, an increase in the volume of profit may be accompanied by a deterioration in the use of productive funds. To give an objective assessment of the work of the repair unit of bases, arsenals, etc., it is necessary to calculate the level of its profitability [18].

To determine the level of profitability of the repair unit of bases, arsenals, etc., the plan profit is compared with the main production funds, which are taken into account at the initial (book value). That is, without less depreciation and normalized working capital, which characterizes the overall profitability of the repair unit of bases, arsenals, etc. It shows the magnitude of the profit per unit of production assets, and therefore directs the employees of the repair unit of bases, arsenals, etc. to improve the use of productive funds for maximum profit.

In addition to the overall profitability of the repair units of the bases, the arsenals, etc., they also compute the calculated profitability, which is defined as the ratio of bookkeeping income minus payment for productive funds, fixed payments and interest payments on bank credit to the average annual cost of the main productive funds and normalization of working capital.

The level of calculated profitability evaluates the implementation of the plan, determines the rates of contributions to economic incentive funds, which form the bulk of the incentive funds.

The above can be represented as formulas:

$$P_{gen} = \frac{P_{re}}{S} 100$$

where P_{gen} – common profitability;

 P_{re} – profit from sales of products according to plan;

S – average cost of the main funds and normalized working capital to calculate profitability;

$$P_{ret} = \frac{P_b \quad (P_s + P_{fp} + P_{il})}{S \quad (S_{pf} + S_{ep})} 100$$

where P_{ret} – estimated profitability;

 P_b – balance sheet profit;

 P_s – payment for funds;

 P_{fp} – fixed payments to the budget;

 P_{il} – interest on the bank loan;

 S_{pf} – preferential funds;

 S_{ep} – Funds that are exempt from payments.

In modern conditions, the most important areas of increasing the profitability of the repair unit of bases, arsenals, etc., and therefore, the effectiveness of repair of WME are technical progress, use of production reserves, lower cost and increase of the quality of production, growth of savings and continuous improvement of the use of production funds.

Technological advances make it possible to replace obsolete facilities with low labor efficiency with high-performance specimens, through which, while saving human labor, more production and better quality per unit of material, labor and financial costs can be produced. Technological advances are closely connected to the possibility of improving the use of productive funds, reducing cost, increasing accumulation and, consequently, increasing the profitability of the repair unit of bases, arsenals and so on.

Increasing production scale and qualitative shifts in the economy are raising new requirements for the organization and management of repair of WME, dictate the need for further improvement of methods of planning and economic stimulation of repair units of bases, arsenals, etc.

Economic incentives should, firstly, encourage repair units to adopt tense plans, use financial labor material, and resources rationally, and secondly, stimulate accelerated scientific and technological progress, productivity and improved product quality.

Currently, three funds of economic incentives are being created: a fund of material incentives, a fund of socio-cultural events and housing construction and a fund of production development in the repair units of bases, arsenals.

Economic incentive funds created by deductions from profits and directly related to the main indicators of economic and financial activity of enterprises are designed to stimulate high production efficiency, ensure a harmonious combination of the interests of each employee with the interests of the production team and society as a whole. In accordance with the procedure adopted, the Material Incentive Fund and the Social and Cultural Measures and Housing Fund are formed from profits at the rates set in percentage to the payroll, and the Production Development Fund – at the rates set in percent to the average annual value of the main productive funds.

There are two types of standards: one for stationary repair units for each percent of estimated profitability, and the other for each percent of product sales growth.

When the targets are exceeded, the rates of deductions are lowered, which economically interests the repair units in adopting tense plans, taking into account the mobilization of internal resources.

Considering the experience of OCF (ATO), the basis of military repair of WME is the current and average repair of samples of WME, which is performed by repair and restoration military formations (units) [1-3].

Current repair is performed, as a rule, in the repair units of military units on the finished parts, assemblages, aggregates.

The cost of current repairs of WME samples will consist of a number of components: the cost of newly installed WME parts, assemblages, aggregates, depreciation of equipment, the cost of retaining personnel of repairmen involved in the restoration of WME samples, average cost of maintenance set for one current repair, and more [19].

The cost of re-installed purchased parts of assemblies, aggregates on the WME, is usually determined by the price lists.

It is somewhat more difficult to determine other costs, but they can also be obtained by generalization or calculation.

Determining the cost of depreciation of equipment for one current repair can be determined on the basis of the supply norms for production and auxiliary equipment, with the help of devices and tools for repair and restoration military formations (units) in accordance with orders of the Minister of Defense, taking into account the results of processing and analysis of statistical data. On the basis of statistics, the repair and reconstruction unit of the military formation conducts about 100 current repairs in peacetime a year, and in a special period everything will depend on the probable failure of the WME from combat damage.

It is possible to determine the cost of the maintenance set from the calculation of the cost of the maintenance set for one current repair of each WME nomenclature.

Thus, all components can be determined either by summarizing statistics data or by calculation, which allows to determine the cost structure of ongoing repairs.

As a rule, the cost of current WME repair is outweighed by the cost of purchasing newly installed parts, assemblies and aggregates, as well as the cost of purchasing a maintenance set.

Costs for current repairs of WME samples can also be estimated by specific indicators of various kinds. For example, an estimate can be made for the cost of current repairs per 1,000 km of mileage, inter-service life for the cycle of exploitation, or average annual costs.

To estimate the cost of current repairs of WME samples per 1,000 km of run, a coefficient $K_{O=1000}$ is adopted. It is determined by the ratio:

$$K_{Q=1000} = \frac{Q_{cr} n_{ncr}}{0,001 S_{irr}},$$

where Q_{cr} – the average cost of the one current repair;

 n_{ncr} - the amount of current repairs during the cycle of exploitation;

 S_{ip} – inter-service life for the cycle of exploitation.

The average annual cost is estimated by a coefficient K_{or} . It is determined by the ratio:

$$K_{Qr} = \frac{Q_{er}n_{ner}}{0,001S_{irn}}K_y$$

where K_y – the coefficient of annual exploitation.

Annual expenditures of material resources depend on the norms of annual operation of samples of WME and the specific state of the military formation. In terms of the cost of current repairs for the different nomenclature of WME samples, they will differ. This is due to the fact that the parts, assemblies and aggregates have different costs, in addition the annual exploitation coefficient K_y for each sample of the WME are different, which also has a negative impact on the cost of current repairs.

The cost of an average repair of a WME, as well as current repair, consists of a number of components (purchase parts, assemblies, aggregates, depreciation of equipment, etc.).

The order and sequence of determining cost is similar to determining the cost of current repairs.

The average repair of WME samples is performed in repair and restoration military formations of operational and strategic levels, as a rule, on finished aggregates and assemblages [20].

The cost of newly installed on WME samples of purchased parts, aggregates and assemblages is determined by the suppliers' prices. The depreciation cost of equipment is determined using the same methodology as for current repairs. On the basis of statistics in peacetime, the repair and restoration formations makes about 40 average repairs a year. Therefore, the depreciation cost of the equipment can be determined by calculating the cost of one average repair of each WME nomenclature. Other components are defined in the same way, which, ultimately, makes it possible to determine the structure of the cost of an average repair.

The cost of average repair of WME samples is mainly dominated by the cost of purchasing purchased parts, aggregates and assemblies. The value of these costs is 97 ... 98% of the total cost of the average repair.

Cost of average repair per 1000 km of mileage over the repair period is also estimated using the coefficient $K_{Q=1000}$, which is determined by the ratio

$$K_{Q=1000} = \frac{\overline{Q}_{ar}}{0,001S_{ip}}$$

where \overline{Q}_{ar} – the cost of average repairs per cycle of exploitation.

The cost of average repair per year of exploitation is determined by the coefficient $K_{o_{x}}$, which is determined by the ratio

$$K_{\mathcal{Q}_{ar}} = \frac{\overline{\mathcal{Q}}_{ar}}{0,001S_{irn}}K_{y}$$

Reducing the magnitude of these indicators is possible by finding ways to reduce material costs

for routine repairs and improve the quality of repair in order to increase inter-repair terms.

Equally important is the reduction in the cost of purchased parts, aggregates and assemblies. This event should be carried out first of all at the factories of production of spare parts of the defense-industrial complex on the national scale. A major role in this should also be played by military plants for overhauling the WME that produce aggregates for military repairs. Reducing the cost of aggregates can greatly reduce the cost of military repairs of WME samples.

<u>Conclusions</u>

Thus, among the economic levers of influence on repair production, an important place belongs to profit and profitability, which are the main indicators of repair of WME, a source of savings, growth of production and incentive funds of stationary repair units. In doing so, the economic levers act not in isolation but in close connection and interdependence, forming a single economic system.

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Reducing of the financial and economic costs for movable repair and restoration military formations (units) will depend on cost reductions on material and technical equipment and improving the quality of repair.

Thus, the stationary and moving components of the repair of the WME ensure high efficiency of repairing the WME in peacetime and in a special period.

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