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Formation of base data list and content for determining of the ways for military teams procurement with armament

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Abstract: Maintenance of samples of weapons is carried out at the stages of their life cycle and is carried out on the basis of coordination of actions of the customer and the consumer with a wide range of organizations from the main developer to the co-executors, which does not exclude the occurrence of conflict situations. This leads to the problem of implementing the optimal synthesis of such a complex system and does not allow to direct efforts to achieve the extremum of the target function of the system as a whole. Therefore, the emergence of such a problem and the existing conflicts in the process of determining the means of providing arms to military formations is considered as a complex organizational system, and the difficulties of direct solution of the problem of optimal synthesis in this case are related to: the interconnections of a complex system (between systems of the lower level and elements of the system); limited programming abilities; the construction of a mathematical model, etc.; and cause the need to find solutions to this problem.

The methods developed at present allow analytically to calculate the technical perfection of the weapons samples that are considered for providing military formations, as investigated when choosing for procurement or development. Such tasks are deterministic, but, considering costs at all stages of the life cycle, there may be stochastic (probable ones) that can be solved by expert methods. At present, the list and content of the source data when choosing ways of providing

weapons are not defined at all stages. Thus, having them strictly non-formalized, the statement of the problem of synthesis is carried out under conditions of uncertainty, which in most cases is solved by heuristic methods, which in turn allows elements of subjectivity.

Having determined the list and content of the initial data, it is possible to pre-implement the calculations in cost form (strictly mathematical) in the form of expenses, having carried out the projection of expenditures at the stage of the weapon's life cycle, and such a list to be chosen according to the criterion of the problem of synthesis, while defining the criteria of the restrictions, and to use these data for assessing the quality of this type of weapons and the cost of the stages of their life cycle. Also, in case of incomplete receipt of such data in cost form, with their partial, such an assessment will allow to determine between the corresponding methods when solving the problem of choosing ways of providing arms in the medium term. Even if this method is not analytical, then the relevant statistics will help to reduce the degree of uncertainty and subjectivism when choosing ways to provide armed skills by expert means.

Keywords: weapons and military equipment, data source, artificial intellect.

References: 5, tables 0, figures 4.

1. Introduction

Warsaw's pact states, which in end of XX century pulled out of that pact because of change of political situation, were forced to lead a national military-technical policy, which is differed from previous existing one. The ways of armament and military equipment (AME) development of that states were different on basis of industry existing capabilities, financial possibilities, military-technical cooperation, etc. The relations between Ukraine and Russia Federation (RF) have a stable trend to deterioration after beginning of RF aggression. Beginning from the 1-st April 2019, Ukraine has stopped finally a friendship and partnership with RF provided by Agreement between RF and Ukraine, which was ratified by Ukrainian parliament in 1998.

Today Ukraine is needed in imperfection of it military and technical policy taking into consideration, that the existing equipage of AME in Ukraine Military Forces (MF) on kinds and corps was not created by national industry and taking into consideration an experience of the former Warsaw pact states, which had AME, but technical supervision during life cycle (LC) was implemented by RF as AME developer. The issues deal with choice of the ways on procurement of military teams of Ukraine Safety and Defense Sector (S&DS) with AME get now the most actuality during development of armament programs especially.

Last researches analysis. Determination of the S&DS demands in qualitative and numerical state of relevant kind of AME (or it structural elements) is the first element (unit 1) in early proposed algorithm [1] for decision of the issues deal with choice of the ways on procurement of military teams with armament. The solutions are accepting considering the assessment results of both military infrastructure (unit 2) and enterprises of defense-industrial sector (DIS, unit 3). The possible alternatives (unit 4) are considering if there is impossible to develop the AME (or it structural elements) provided in the Ukraine S&DS demands by national enterprises of DIS. All mentioned assessments require a comparative analysis connected with determination of LC stages cost and quality of relevant AME kind (units 5 and 6). Choice of alternative variant for possible way of military teams procurement with relevant kind of AME is final procedure of proposed algorithm (unit 7).

Early unresolved issues. Necessity to form the base data list and content for every mentioned unit, as separate part of unsolved general issue, is arising in proposed algorithm [1] presented in fig. 1 as ontological model. Three indexes: achieved result (*W*), financial expenditures (*C*) and time (*T*) are using for assessment in units 1-6 and enumeration of the best variants.

W – achieved result indexes; it reflects the rate of procurement of military forces with relevant technical level AME relatively to general necessity in that AME.

C index has a cost form and it reflects economic content of measures on military forces procurement.

T – time index; it reflects duration of measure under execution.

As rule, depends of the tasks under execution, one index is choosing as criterion and both other indexes act as limitations:

$W \rightarrow max$ at $C \le C_{allocated}$, $T \le \tau_{prescribed}$;

$C \rightarrow min$ at $W \ge W_{required}$, $T \le \tau_{prescribed}$;

$T \rightarrow min$ at $W \ge W_{required}$, $C \le C_{allocated}$

Tasks assignments on choice may be different for units 1-6. That was not considered in paper [1]. Task of effectiveness upgrading is deciding if scope of available resources and measure purpose are known. The tasks on effectiveness upgrading are implementing, when activity result is prescribed and task on choice of AME characteristics wherein resources expenditures for purpose are vanishing to minimum, is deciding. Modifications of these tasks may appear in some situations.

Setting objective. Formation process of base data list and content may be improved within determination of the ways on procurement of military teams with armament, if to superpose the measures in units 1-6 (fig. 1) on existing stages of typical LC of the products. It is a task this paper.

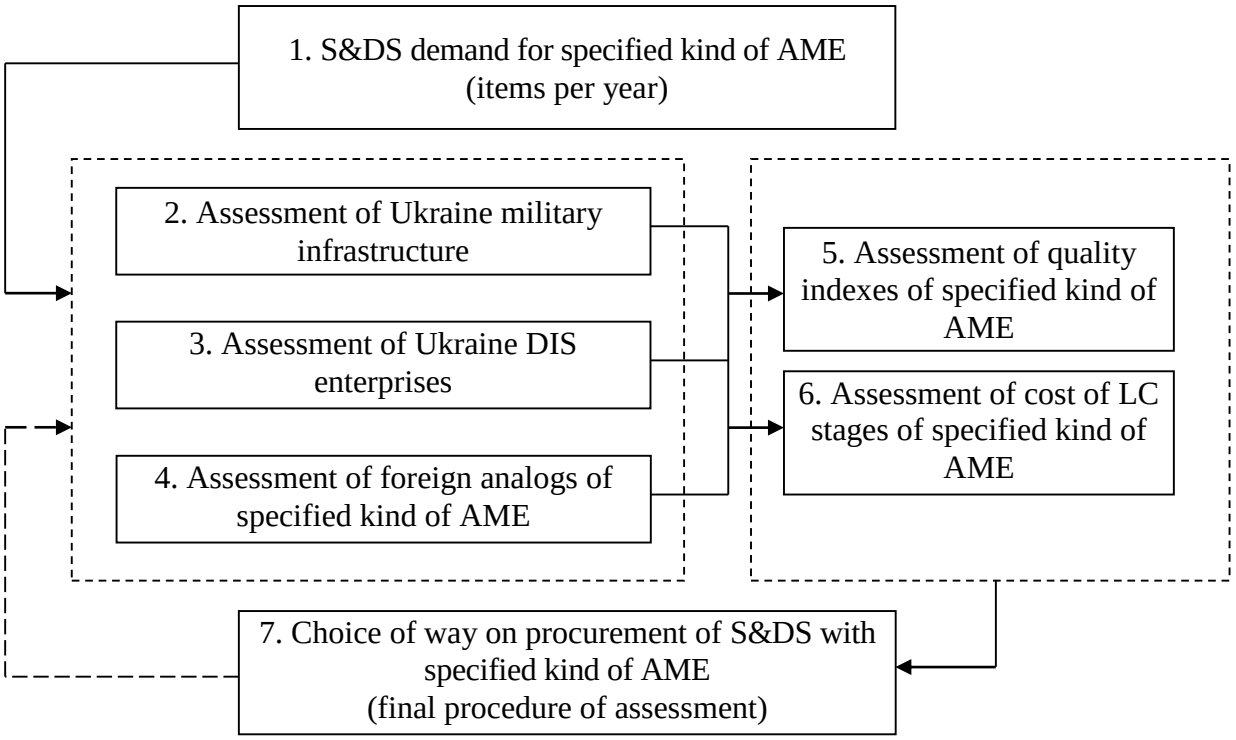

Fig. 1. Algorithm for analysis of factors (criterion) influencing on choice of way on procurement with specified AME in accordance with determined demand

2. Results and Discussion. Determining the base data for choice of the ways on procurement of S&DS with specified kind of AME, let we consider every element in area of existing stages of LC as complex system of organization kind (fig. 2) and separate element stages as sub-systems, which have system attributes and its can execute some system task. Synthesis is most important and responsible stage in research of the complex systems, and it task is choice such values and parameters to get the necessary functional characteristics of system. These tasks may be determinate, stochastic and they are deciding in uncertainty conditions.

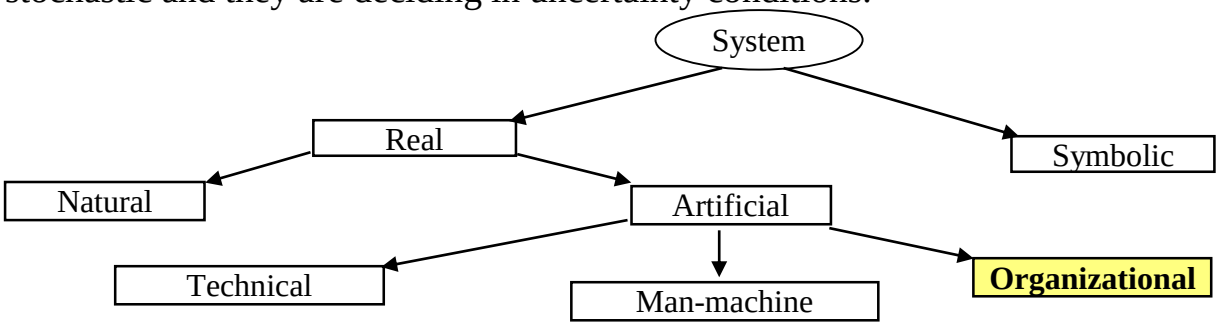

Fig. 2. Dividing system by groups

Because of the demands in relevant AME form the General Stab of Ukraine MF, at first let we consider unit 2 (fig. 1) at forming of list and content of base data in present paper. Analysis of other units would be considered in further researches. Considering three indexes *W, C, T* and assessing military infrastructure let we superpose it on stage of LC, which is close to the "operation" LC stage. The following works kinds are included into that stage: accept to operation, normal operation and decommissioning (fig. 3).

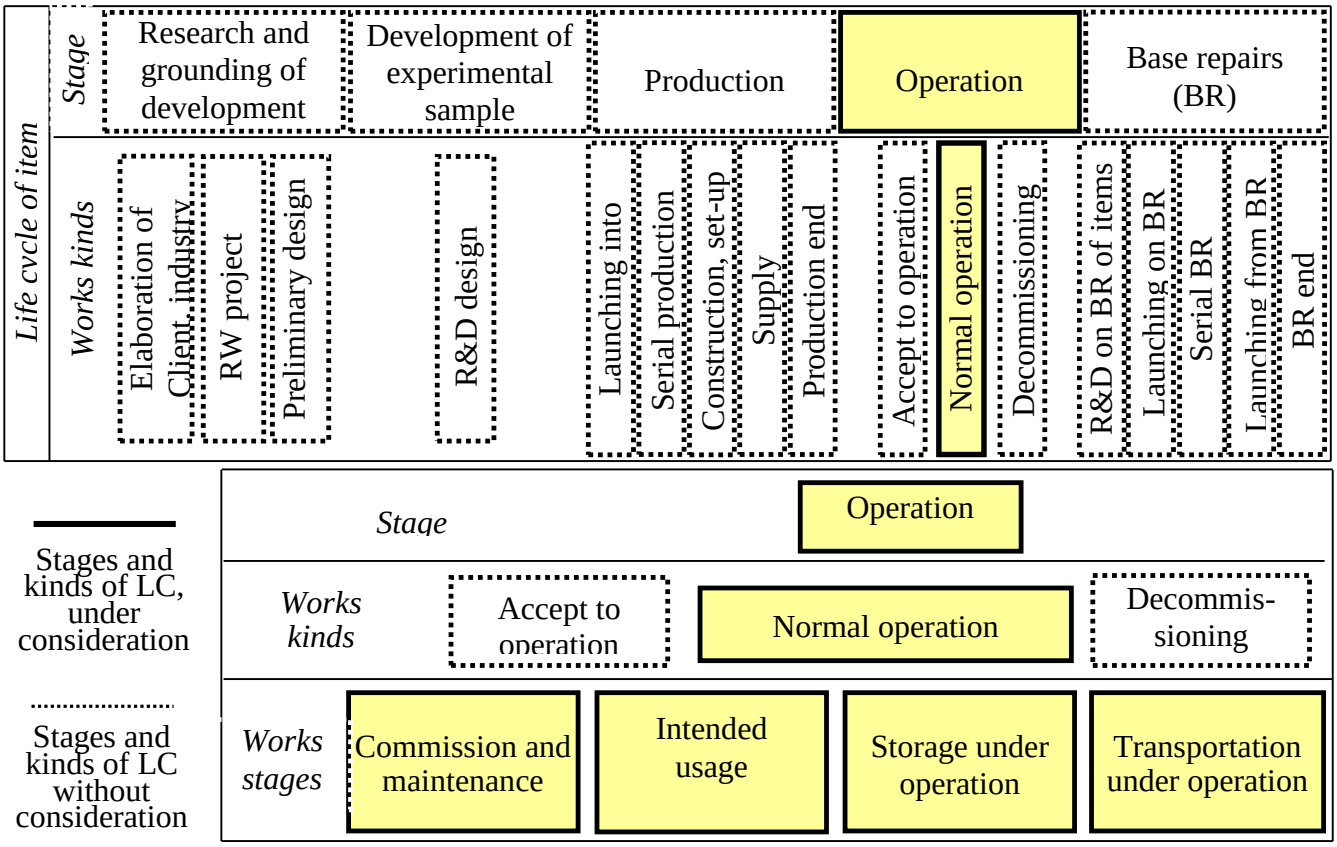

Fig. 3. Extraction of LC stage according to assessment of military infrastructure

Let we carry out analysis of biggest expense portion – Normal operation – taking into consideration methodical component of accept to operation – Assessment of technical level (perfection) on new item – and ignoring of Accept to operation and Operation end [2, 3, 4].

In paper [5] the LC stage "Operation" is considered from view point of expenditures: initial expenditures for technical operation of AME, expenditures for technical operation of AME, expenditures for battle and technical training. Therefore, correlating these expenditures with stages of the item's operation, we can consider it as list of base data under assessment of military infrastructure. It is shown schematically in fig. 4.

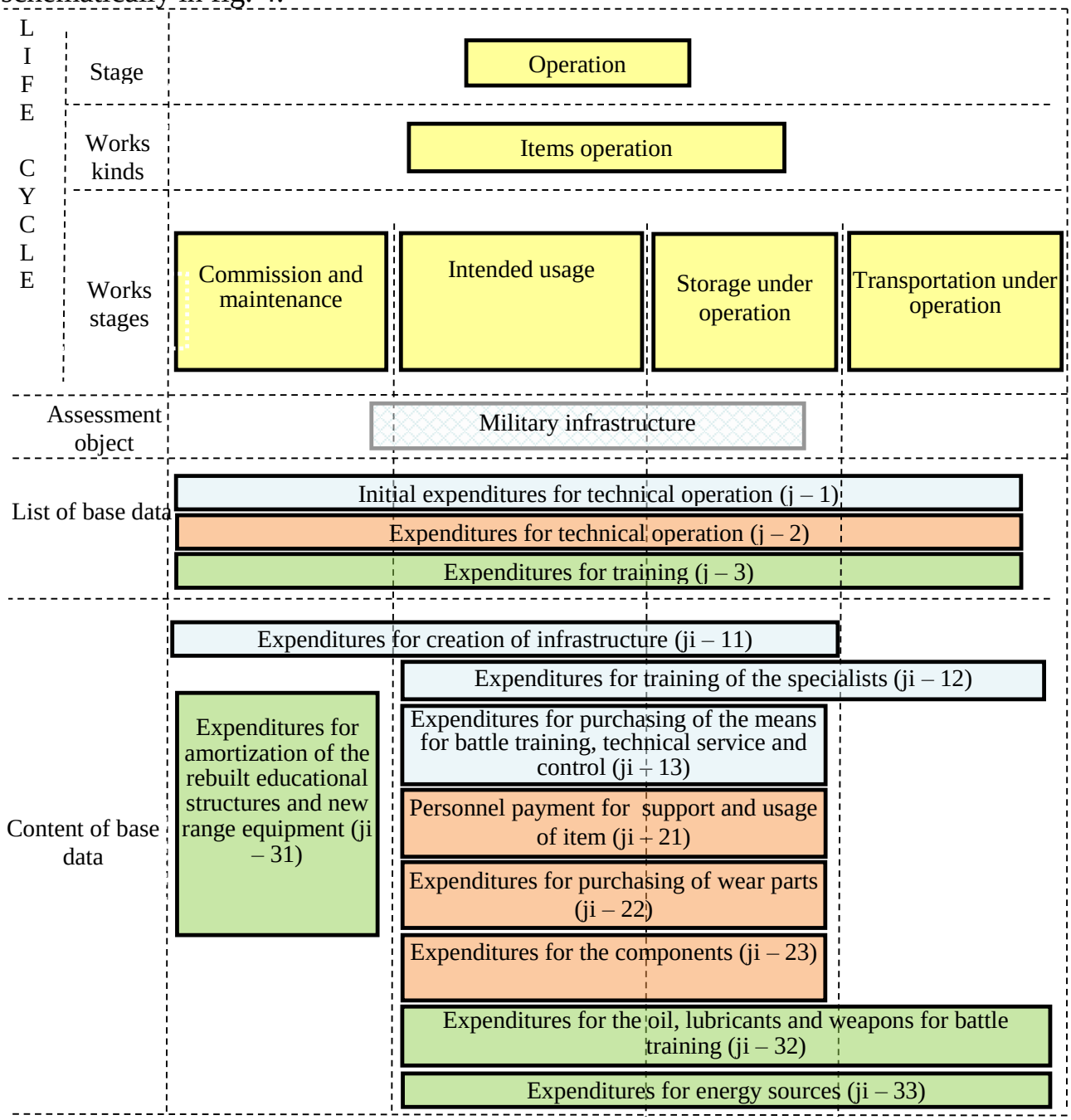

Fig. 4. Superposition of military infrastructure assessment on "Operation" LC stage

If superpose these basic data on LC, we have possibility to get/ not get/ get partially the statistical data on relevant stages. Whereas it is influencing on relevant synthesis methods: analytic (math exactly), simulation (it concedes probability) and heuristic (non-formalized exactly).

Let we determine the military infrastructure assessment by coefficient:

$$K_{MIAC} = \sum_{j=1}^{j=k} K_{EPCj} \left(\sum_{i=1}^{i=n} \frac{A_{jiRI}}{A_{jiAI}} \right), \quad (1)$$

where K_{MIAC} – military infrastructure assessment coefficient;

K_{EPC} –expenditures purposefulness coefficient for "Operation" LC stage of item under research for *j* expenditures list;

A_{jiRI} – numerical value for *j* expenditures list, *i* – for content of expenditures of item under research;

A_{jiAI} – numerical value for *j* expenditures list, *i* – for content of expenditures of available item;

κ – list of the expenditures in "Operation" LC stage;

n – content in *i*-group of expenditures list.

$$A_{11RI} = \frac{1}{\tau_{year} \cdot N^{\text{Te}}} \cdot \sum_{\text{i}=1}^{N_{inf}} \text{C}_{\text{i}}^{inf} \cdot \text{a}_{N^{\text{Te}}}, \quad (2)$$

where N^{Te} – average number of AME items in field equipage, which use the infrastructure objects for ensuring of technical operation (TO);

$\text{a}_{N^{\text{Te}}}$ – index characterizing a part of infrastructure objects work time for ensuring of AME items TO under research;

N_{inf} – number of the infrastructure objects, which are necessary for carrying out of technical service and repair and battle training of AME field equipage under consideration;

C_{i}^{inf} – cost of *i* infrastructure object;

τ_{year} – calculation year running hour of AME (it is Unit amount for AME item run) [5].

$$A_{12RI} = \frac{1}{\tau_{year} \cdot N^{\text{Te}}} \cdot \left(\sum_{\text{i}=1}^{N_{spec}} \text{A}_{\text{i}}^{spec} \left(N_f \right) \cdot \text{C}_{\text{i}}^{ctss} \cdot \text{a}_{N^{\text{Te}}} \right), \quad (3)$$

where N_{spec} – number of the specialties of personnel, which are necessary for carrying out of technical service and repair and battle training of AME field equipage under consideration;

$\text{A}_{\text{i}}^{spec}(N_f)$ – number of the specialists of *i* specialty, which are necessary for technical service and repair and battle training of N_f items of AME;

$\text{C}_{\text{i}}^{ctss}$ – cost of training of *i* specialty specialist [5].

$$A_{13RI} = \frac{1}{\tau_{year} \cdot N^{\text{Te}}} \cdot \left(\sum_{\text{i}=1}^{N_{mtsbt}} n_{\text{i}}^{mtsbt} \left(N_f \right) \cdot \text{C}_{\text{i}}^{mtsbt} \cdot \text{a}_{N^{\text{Te}}} \right), \quad (4)$$

where N_{mtsbt} – number of kinds of technical service and control means, which are necessary for carrying out of technical service and repair and battle training of AME field equipage under consideration;

$n_{\mathrm{i}}^{mtsbt}\left(N_f\right)$ – number of technical service and control and battle training means of *i*- kind, which are necessary for technical service and battle training of N_f items of AME;

$\mathrm{C}_{\mathrm{i}}^{mtsbt}$ – cost of technical service and control means, which are necessary for carrying out of technical service and repair and battle training of *i* nomenclature [5].

$$A_{21RI} = \frac{\mathrm{T}_{year}^{mh} \cdot \sum \mathrm{C}_{\mathrm{i}}^{mh} \cdot \mathrm{A}_{\mathrm{i}}^{nss} \cdot}{\tau_{year} \cdot N_f} \cdot \mathrm{a}_{N_f^{pio}}, \quad (5)$$

where N_f – average number of AME items in field equipage, which are used and serviced;

$\mathrm{A}_{\mathrm{i}}^{\mathrm{nss}}$ – number of the specialists of *i* specialty, which are necessary for usage and service of AME;

$\mathrm{C}_{\mathrm{i}}^{mh}$ – average cost of man-hour for specialists *i* specialty involved in AME usage and service (taking into account all taxes and administrative expenses);

$\mathrm{T}_{\mathrm{year}}^{\mathrm{mh}}$ – year fund of work time of the specialists, which are necessary for AME usage and service;

$\mathrm{a}_{\mathrm{N}_{\mathrm{f}}^{\mathrm{pio}}}$ – index characterizing a part of infrastructure objects work time for usage and service of AME [5].

$$A_{22RI} = \frac{1}{\tau_{year} \cdot \mathrm{T}_{\mathrm{т.с}}} \cdot \sum_{\mathrm{i}=1}^{m_{pts}} \left(\left[\frac{\tau_{year} \cdot \mathrm{T}_{sl} - 1}{\tau_{\mathrm{i}}^{pts}} \right] \cdot \mathrm{C}_{\mathrm{i}}^{pts} \right), \quad (6)$$

where T_{sl} – service life of AME item (years);

m_{pts} – number of works on periodic technical service provided by the requirements to plan technical service;

τ_i^{pts}– periodicity of *i* work on periodic technical service;

$C_i^{\ pts}$– average cost of the materials for elimination of the single failure *i* type component [5].

$$A_{23RI} = \frac{1}{\tau_{year} \times \mathrm{T}_{sl}} \cdot \sum \{\mathrm{i} \in (1 \ldots N_{com}) | \mathrm{E}_i = \mathrm{TOE}\} \left(n_i \cdot \left[\frac{\tau_{year} \times \mathrm{T}_{sl} - 1}{\tau_{\mathrm{i}}^{res}} \right] \cdot (\mathrm{C}_i + \mathrm{C}_i^{cm}) \right), \quad (7)$$

where N_{com} – number of components types in structure of AME item;

E_i – method of technical operation for *i* type component: $E_i \in$*{TO after failure, TO before failure, TO after expiry life}*;

τ_i^{res}– intended resource for *i* type component;

C_i – cost of *i* type component;

C_i^{cm} – average cost of the materials, which are using, when there is a work on renovation of *i* type component resource [5].

Amortization expenses are expenditures for compensation of gradual wear of the items or expensive objects, which are operating (structures, special machines for service, airdrome and field equipment etc.).

$$A_{31RI} = C_{amor.av.i} + C_{amor.ad.i}, \quad (8)$$

where $C_{amor.av.i}$ – cost of expenses for support and amortization of the available infrastructure means;

$C_{amor.ad.i}$ – cost of expenses for support and amortization of the additional infrastructure means[5].

$$A_{32RI} = \frac{\sum n_{i.year}^{ew.kt} \cdot C_i^{ew}}{\tau_{year}^{kt}} + \frac{C_{ol} \cdot \tau_{year}^{kt}}{\tau_{year}}, \quad (9)$$

where $n_{i.year}^{ew.kt}$ – annual expenditure of the *i* type weapons, which are planning during all kinds trainings;

C_i^{ew} – average cost of *i* type weapons, which are applied, when AME item is used;

τ_{year}^{kt} –year running hour of AME item , which is planning during all kinds trainings (hour of flight, kilometer of race, motor-hour, etc.) [5].

$$C_{ol} = \sum п_i^o \cdot C_i^o + \sum n_i^l \cdot C_i^l, \quad (10)$$

where: C_{ol} – cost of oil, lubricants per Unit of AME item running (hour of flight, kilometer of race, motor-hour, etc.);

C_i^o – cost of Unit of *i* type oil;

C_i^l – cost of Unit of *i* type lubricant;

$п_i^o$ – data on consumption of *i* type oil, when AME item is using, per Unit of running (km, hour of flight, etc.), $n_i^o = n_{i.m}^o + \alpha_i n_{i.p}^o$;

$n_{i.m}^o$ – specific consumption of oil per Unit of AME item running (hour of flight, kilometer of race, motor-hour, etc.), when item is moving;

$\alpha_i n_{i.p}^o$ – specific consumption of oil per Unit of AME item running (hour of flight, kilometer of race, motor-hour, etc.), when item motor works on place;

α_i – relation of time of AME item motor work on place to time of it work at movement;

n_i^l – data on consumption of *i* type lubrication, when AME item is using, per Unit of running (hour of flight, kilometer of race, motor-hour, etc.), $n_i^l = a_i^{мм} \cdot n_i^o$;

$a_i^{мм}$ – coefficient of *i* type lubrication consumption in relation to oil consumption n_i^o [5].

$$A_{33RI} = \frac{C^{ee} \cdot \sum N_i^{ti} \cdot P_i^{ti} \cdot \tau_{i.year}^{ti}}{\tau_{year} \cdot N_f} \times a_{N_f^{pio}}, \quad (11)$$

where C^{ee} – average cost of 1 kWt-hour of electrical energy;

N_i^{ti} – energetic power of every kind infrastructure objects, which are necessary for training;

N_i^{ti} – number of every kind infrastructure objects, which are necessary for training.

3. Conclusions and prospects of further research. Technical support of armament items is carrying out on all stages of it LC on base of coordination actions between client and user with wide spectrum of the organizations – from principal developer to co-contractors, which are designing separate sub-systems, and which are involved in disposition of items. It leads to arising of issue – optimal synthesis of that complex system.

Conflict situations may arise even in initial development stages, when there is need the clear works synchronization in maximally limited time whereas co-contractors accept their solutions on the basis of local purposes. It does not permit to direct the forces to get extreme for objective function in whole. Therefore the difficulties of direct solution for task of optimal synthesis are connected with interrelations of complex system (between systems of lower level and system elements) and with limited possibilities in software engineering and math modeling and these difficulties generate a need for seeking of the ways for solution of that issue.

If we have a relevant list and content of base data considered in "Operation" stage of LC (unit 2, fig. 1) as criterion for synthesis task and if we have chosen limitation criterion, then we can get the statistical data for unit 6 (fig. 1). If we have incomplete data, then the proposed method gives chance nevertheless to get these data partially and to improve process deals with choice of the ways on procurement of military teams with armament in medium-term prospective (unit 7, fig. 1), using both the statistic data deal with technical perfection of item under research (unit 5, fig. 1) and the relevant modern scientific methods. The proposed list and content of base data will help to decide a task on choice of the ways on procurement of military teams with armament by expert method decreasing the uncertainty state, even if these methods will not be analytic.

In further researches authors have purpose to consider other objects deal with assessment of the Ukrainian industry enterprises (unit 3, fig. 1) and foreign analogs of AME (unit 4, fig. 1), when the ways on procurement of military teams with armament are choosing in medium-term prospective.

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Формирование перечня и содержания исходных данных для определения путей обеспечения вооружением воинских формирований

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Аннотация: Определён перечень и содержание исходных данных при обеспечении войсковых формирований вооружением, на одном из этапов пути выбора вооружением, осуществивши оценку войсковой инфраструктуры. Предложено на стадиях жизненного цикла использовать всевозможные статистически-математические методы, которые при использовании в существующем алгоритме анализа факторов, улучшат процесс формирования программ вооружения

Перечень и содержание соответствующих исходных данных позволит осуществить расчёты, в стоимостной форме (в виде ассигнований), спроектировавши такие расходы на стадии жизненного цикла вооружения, а этот перечень избрать как критерии при решении задачи синтеза. При неполном получении состава данных соответствующего перечня, получивши его даже частично, позволит уменьшить степень неопределённости и субъективизма, разрешая задачу выбора путей обеспечения вооружением экспертным путём.

Ключевые слова: вооружение и военная техника, исходные данные, жизненный цикл.

Библ.: 5, табл. 0, рис. 4.

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Формування переліку і змісту вихідних даних для визначення шляхів забезпечення озброєнням військових формувань

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Анотація: Визначений перелік і зміст вихідних даних, при забезпеченні військових формувань відповідним озброєнням, на одному з етапів шляху вибору озброєння, здійснивши оцінку військової інфраструктури. Запропоновано на стадіях життєвого циклу використовувати можливі статистично-математичні методи, які при застосуванні в існуючий алгоритм аналізу факторів покращать процес формування програм озброєння.

Перелік і зміст відповідних даних дозволить здійснити розрахунки, у вартісній формі (у вигляді витрат), здійснивши проекцію таких витрат на стадії життєвого циклу озброєння, а такий перелік обрати за критерії при розв'язанні задачі синтезу. При неповному отриманні змісту даних відповідного переліку, отримавши його навіть частково, дозволить зменшити ступінь невизначеності та суб'єктивізму вирішуючи задачу вибору шляхів забезпечення озброєнням експертним шляхом.

Ключові слова: озброєння та військова техніка, вихідні дані, життєвий цикл.
Бібл.: 5, табл. 0, рис. 4.

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