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VALUE ANALYSIS OF THE BLOCKS AND MECHANISMS OF THE KALASHIKOV ASSOULT RIFLE

Introduction of the International System of Quality ISO 9000 in Ukraine requires from the producers to use the methods of the project solutions analysis. Both input and output data of the project data must be analyzed. Enterprises, creating or developing quality products obligatory apply either standard technologies of functional-cost analysis or use their own technologies.

The given paper contains functional-cost analysis of the blocks and mechanisms of Kalashnikov assault rifle. Functional model of the blocks and mechanisms of Kalashnikov assault rifle has been developed.

Classification of the functions of the functional model of blocks and mechanisms of Kalashnikov assault rifle is considered. Utility factor of the blocks and mechanisms of Kalashnikov assault rifle has been determined by means of construction of the priorities matrix according to the known calculation technique.

Generalized expenses criterion in the process of technical and production systems design takes into account the expenses at all stages of the system life cycle, for their assessment the expenses matrix of the blocks and mechanisms of Kalashnikov assault rifle has been constructed, cost coefficient is determined from this matrix.

Utility diagram of the functions of the blocks and mechanisms of Kalashnikov assault rifle, diagram of functions ranking relatively the utility coefficient, functional-cost diagram, diagram of the functions expenses, diagram of functions ranking relatively expenses coefficient, diagram of the values of values of the index of the functional cost of the functions, diagram of functions ranking relatively the functional cost index have been constructed.

Functions of the blocks and mechanisms of Kalashnikov assault rifle which have positive functional-cost index and the highest rating among the considered functions have been determined according to the constructed diagrams. Operations or functions, having the highest functional-cost index and rank are the operations, improvement of which leads to further development of the system or achieving the objective of the analysis.

Key words: *Kalashnikov assault rifle, functional-cost analysis, functions classification, utility coefficient, priorities matrix, expenses coefficient, functions utility diagram, functions ranking diagram, functional-cost diagram, functions expenses diagram.*

Introduction

For making rational and substantiated decision functional-cost analysis, combining various methods of the aggregated analysis of the systems, creative search, optimization and decision choice should be used [1].

The base of functional-cost analysis is the analysis of the functional perfection, ways of improving the system by means of comparison of its separate function utility and expenses for its realization.

Objective of performing functional-cost analysis is to provide necessary utility of the system at minimum possible total expenses.

Thus, decision – making in case of functional-cost analysis is carried out on the base of two criteria – utility and cost [2, 3].

In Ukraine, for the implementation of the International System of Quality ISO 9000 the manufacturer should use the methods of design solutions analysis. Such analysis should be carried out both for the input data of the project and output data. That is why, the enterprises, which develop or create quality products obligatory use either typical technologies of the analysis or functional-cost analysis or use their own technologies.

Thus, functional-cost analysis is aimed at provision of the needed consumer properties of the object with minimal possible losses of the resources at all stages of the production process [4].

Problem set-up

Main role in the optimization of the engineering projects, aimed at improvement of the production efficiency is devoted to performing the comprehensive study of the decisions made. Analysis, as the method of study, enables to reveal the available discrepancies and nonconformities in the developments, objects, systems and methods, establish cause-and-effect relations, providing the obtaining of information.

Among the known methods of analysis (engineering, technical-economic, economic, ecological) special position is occupied by functional-cost analysis, it is recommended to apply such analysis for the design of new products and technologies, upgrading of the equipment and start-up of the new materials, reconstruction of the industrial objects, reduction of the productive costs, etc.

The essence of the method of functional-cost analysis is in practical decomposition of the object (constructions, technologies, production processes management) into the components for the determination of their role and cost in the general system, assessment of their functions and reduction of all the unnecessary costs.

Experience of using functional-cost analysis in automobile building shows [5]:

–on basic elements (functions) of the system, which represent 45 % of their total number, falls 80 % of the total cost of the system, that is why, consideration of the above-mentioned elements must be of top priority;

– errors of the standard cost calculation in the process of performing functional- cost analysis must be by an order of magnitude less of the volume of the cost reduction .

Analysis of recent studies and publications

Functional-cost analysis is widely used by the industrial companies of the USA, Great Britain, France and other countries with the developed market economy. One of the founders of functional-cost method is the employee of the company «General Electric» (USA) – engineer Lourence D. Miles [6]. He came to conclusion that production cost reduction should be started from the analysis of the product properties and technical functions of its components. Soviet economists paid special attention to the importance of this type of analysis in the system of methods, aimed at improvement of products quality and production efficiency.

In Ukraine functional-cost analysis was considered as the component of crementation – science that studies the methods of activation of creative thinking. Outstanding specialists, who made considerable contribution in the development of functional-cost analysis are: M. Ivanov [2], N. Veselovska [3], Z. Lytvyn [4], I. Tsygylyk [7], I. Prokopenko [8], V. Zelinskyi [9], I. Tverdokhlib [10], P. Kartavyi [11], O. Okhrimenko [12] and others.

Objective of the research

Objective of functional-cost analysis is minimization of expenses at saving or increasing the usage of object functions and enhancement of its utility for the consumers at the stages of the design, manufacturer and functioning.

Thus, **the objective of the research** is development of functional-cost analysis of Kalashnikov assault rifle for determination of the functions of its blocks and mechanisms, which are to be improved.

Main part

Hall mark of the armed forces of Ukraine is legend assault rifle Kalashnikov (Fig. 1) [13 – 16], with this assault rifle plant «Izhmash» entered the world market of small arms. Nowadays Kalashnikov weapon systems are in operational service of the armies of the world, they are used by special operations units of the security agencies or are produced for export sale. Such features of Kalashnikov assault rifle as faultless reliability, possibility of constant improvement of the construction enable to demonstrate the ability of being in demand for many decodes, being the standard for the whole nomenclature of the armaments.

Fig. 1. Kalashnikov assault rifle of various midifications [13]:
a – AKM; b – AKMC; c – AK-74; d – AKC-74; e – AKC-74У; f – AK-74M; g – AK-103; h – AK-108;
i – AK-200; q – AK-203

It is worth mentioning the fact that the upgraded versions of «AKM» – assault rifle «AKM-Ф» and «AKMC-Ф» (Fig. 2) are manufactured on the base of State-owned scientific-production association «Fort» of the Ministry of Internal Affairs of Ukraine (city of Vinnytsia). Characteristic features of these models of the assault rifles is that for the improvement of their tactic-technical characteristics all the springs were replaced, trigger mechanism was adjusted, the lever of automatic trigger was replaced, this provided more smooth triggering. To improve the accuracy characteristics a number of parts were installed, namely, gas tube with Picatinny rail for installation of optical or collimating sight, anatomic pistol grip and fore-grip with the front grip or bipod. Besides, instead of the mouth piece muzzle compensator is installed to reduce displacement of the barrel in case of serial fire. Extended butt of the original construction, directed downwards is installed on «AKMC-Ф» assault rifle [17, 18].

Fig. 2. Modified versions of Kalashnikov assault rifle, manufactured by the State owned scientific-production association «Fort» of Ministry of Internal Affairs of Ukraine:
a – AKM-Ф [17]; b – AKMC-Ф [18]

Kalashnikov assault rifle is individual arms and is intended for the destruction of enemy fighters.

For enemy personal destruction in hand-to-hand combat knife-bayonet is connected to the assault rifle.

Kalashnikov assault rifle consists of the following components and mechanisms (Fig. 3): receiver-barrel assembly with the sighting unit and bult-stock; body cover; breech-block carrier with gas piston; breech-block; return mechanism; forearm with gas tube assembly; trigger and firing mechanism; foregrip; loading case; knife-bayonet [13 – 16].

Fig. 3. Main components and mechanisms of AK-74M assault rifle [13]

Study of the blocks and mechanisms of Kalashnikov assault rifle in the process of functional-cost analysis is based on the functional approach i. e., the components of Kalashnikov assault rifle are considered as the set functions, performed by them. Further, the searching of the better principle of the realization of these functions is performed. Functional-cost analysis is carried out on the base of functional model [3, 4, 10].

Functional model is graphic, tabular or mathematical representation of the arranged set of the system functions and their interconnections. Tabular representation of the functional model comprises the list of functions, performed by the system (selection) and its components. Functional model of blocks and mechanisms or Kalashnikov assault rifle is presented in Table 1.

Table 1

Functional model of blocks and mechanisms of Kalashnikov assault rifle

Number of function	Function	Name of the block (mechanism)
1	Assembly of the parts and mechanisms of the assault rifle	Barrel-Receiver
2	Provision of the barrel locking by the breech and breech closure	
3	Bullet flight direction	Barrel
4	Give the bullet firing velocity	
5	Forwarding the combustion gases from the barrel into the gas-trap piston of the breech carrier	Gas chamber
6	Targeting of the assault rifle during firing on various distances	Sighting unit
7	Prevents the pollution of the parts and mechanisms, located in the receiver	Receiver cover
8	Convenience of using the assault rifle during firing	Butt and pistol grip
9	Breech and trigger mechanism actuation	Action frame with gas piston
10	Seating cartridge into the barrel channel	Breech mechanism
11	Bore locking	
12	Cartridge capsule breaking	
13	Extraction of the shell casing from the bullet chamber	
14	Turning of the breechblock carrier with the breech in front position	Reverse mechanism
15	Rifleman hand protection against burns during firing	Hand guard and fore grip
16	Putting trigger from cocked position or automatic cock	Firing mechanism
17	Delivering a blow on barrel firing-pin	
18	Provision of full automatic or single fire	
19	Firing halt	
20	Firing prevention at open breechblock	
21	Putting the assault rifle on safe position	
22	Flame size reduction during shot	Flash cover
23	Sound force reduction during shot	
24	Arrangement of cartridges and their supply into the receiver-barrel assembly	Loading case
25	Defeat of the enemy in close combat	Knife-bayonet
26	Cleaning and lubrication of the assault rifle	Devices
27	Convenience of carrying arms	Carrying strap

Construction of functional model is only initial stages of functional-cost analysis, final objective of this analysis is establishing of analytical connections between separate factors, influencing the course of the process and final indices of the system operation [19].

After the construction of the functional model classification of the functions is carried out.

Function is the external manifestation of the object features, stipulated by certain actions, regarding the transformation of the input in pacts into output results. Function may have both dynamic character, i. e. it may be directed to the realization of certain work and static character.

Structuring and analysis of functional model provide separation of the main function that

determines the aim and designation of the system and basic functions, without which main function can not be performed as well as separation of the auxiliary and redundant (harmful) function.

Classification of the system functions is carried out according two criteria – character and features of the function. Classification of the functions of the functional model of blocks and mechanisms of Kalashnikov assault rifle is presented in Table 2.

Table 2

Classification of the functions of the functional model of blocks and mechanisms of Kalashnikov assault rifle

№ function	Name of the function	Character of the function	Features of the function
1	Assembly of the parts and mechanisms of the assault rifle	Internal basic	Useful
2	Provision of the barrel locking by the breech and breech closure	Internal basic	Useful
3	Bullet flight direction	External main	Useful
4	Give the bullet firing velocity	External main	Useful
5	Forwarding the combustion gases from the barrel into the gas-trap piston of the breech carrier	Internal basic	Neutral
6	Targeting of the assault rifle during firing on various distances	External main	Useful
7	Prevents the pollution of the parts and mechanisms, located in the receiver	Internal auxiliary	Neutral
8	Convenience of using the assault rifle during firing	External main	Neutral
9	Breech and trigger mechanism actuation	External main	Useful
10	Seating cartridge into the barrel channel	Internal basic	Useful
11	Bore locking	Internal basic	Neutral
12	Cartridge capsule breaking	Internal basic	Useful
13	Extraction of the shell casing from the bullet chamber	Internal basic	Useful
14	Turning of the breechblock carrier with the breech in front position	Internal basic	Useful
15	Rifleman hand protection against burns during firing	Internal auxiliary	Neutral
16	Putting trigger from cocked position or automatic cock	Internal basic	Useful
17	Delivering a blow on barrel firing-pin	Internal basic	Useful
18	Provision of full automatic or single fire	External main	Useful
19	Firing halt	Internal basic	Neutral
20	Firing prevention at open breechblock	Internal basic	Neutral
21	Putting the assault rifle on safe position	Internal auxiliary	Redundant
22	Flame size reduction during shot	Internal auxiliary	Redundant
23	Sound force reduction during shot	Internal auxiliary	Redundant
24	Arrangement of cartridges and their supply into the receiver-barrel assembly	Internal basic	Useful
25	Defeat of the enemy in close combat	External main	Redundant
26	Cleaning and lubrication of the assault rifle	Internal auxiliary	Harmful
27	Convenience of carrying arms	Internal auxiliary	Redundant

External function is realized by the system or its element in the process of interaction with the environment (supersystem).

Internal function is the result of the interactions in the system.

Main function – it is the external function, which reflects the aim and designation of the system.

Useful functions are the functions which meet the requirements of the humans, regarding their utility.

Redundant functions are not obligatory functions but their realization improves the quality of system operation.

Neutral functions – are the functions which do not perform functional loading but provide the place for location of the object in certain place and certain time.

Harmful functions are the functions, which can be simultaneously useful, but have the obligatory element of harmful action.

The next step of functional-cost analysis is determination of the utility coefficients of each function. Utility coefficient was determined by means of construction the matrix of priorities (Table 3) according to the known calculation technique [19 – 23].

Table 3

Matrix of block and mechanisms of Kalashnikov assault rifle priorities

№ of the function	№ of the function																											Sum of the advantages coefficients	Absolute priority	Utility coefficient	Rank of the function
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27				
	Advantages coefficients																														
1	1	1.5	0.5	0.5	1.5	0.5	1.5	0.5	0.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	0.5	1.5	1.5	1.5	1.5	1.5	1.5	0.5	1.5	1.5	33	818	0.04533	8
2	0.5	1	0.5	0.5	1.5	0.5	1.5	0.5	0.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	0.5	1.5	1.5	1.5	1.5	1.5	1.5	0.5	1.5	1.5	32	786	0.04353	9
3	1.5	1.5	1	0.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	0.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	38	996	0.05516	3
4	1.5	1.5	1.5	1	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	0.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	39	1034	0.05730	2
5	0.5	0.5	0.5	0.5	1	0.5	1.5	0.5	0.5	0.5	1.5	0.5	0.5	0.5	1.5	0.5	0.5	0.5	1.5	1.5	1.5	1.5	1.5	0.5	0.5	1.5	1.5	24	562	0.03111	17
6	1.5	1.5	0.5	0.5	1.5	1	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	0.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	37	958	0.05309	4
7	0.5	0.5	0.5	0.5	0.5	0.5	1	0.5	0.5	0.5	0.5	0.5	0.5	0.5	1.5	0.5	0.5	0.5	0.5	0.5	1.5	1.5	1.5	0.5	0.5	1.5	1.5	20	474	0.02624	21
8	1.5	1.5	0.5	0.5	1.5	0.5	1.5	1	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	0.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	36	922	0.05106	5
9	1.5	1.5	0.5	0.5	1.5	0.5	1.5	0.5	1	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	0.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	35	886	0.04910	6
10	0.5	0.5	0.5	0.5	1.5	0.5	1.5	0.5	0.5	1	1.5	1.5	1.5	1.5	1.5	1.5	1.5	0.5	1.5	1.5	1.5	1.5	1.5	1.5	0.5	1.5	1.5	31	754	0.04178	10
11	0.5	0.5	0.5	0.5	0.5	0.5	1.5	0.5	0.5	0.5	1	0.5	0.5	0.5	1.5	0.5	0.5	0.5	1.5	1.5	1.5	1.5	1.5	0.5	0.5	1.5	1.5	23	538	0.02981	18
12	0.5	0.5	0.5	0.5	1.5	0.5	1.5	0.5	0.5	0.5	1.5	1	1.5	1.5	1.5	1.5	1.5	0.5	1.5	1.5	1.5	1.5	1.5	1.5	0.5	1.5	1.5	30	724	0.04009	11
13	0.5	0.5	0.5	0.5	1.5	0.5	1.5	0.5	0.5	0.5	1.5	0.5	1	1.5	1.5	1.5	1.5	0.5	1.5	1.5	1.5	1.5	1.5	1.5	0.5	1.5	1.5	29	694	0.03846	12
14	0.5	0.5	0.5	0.5	1.5	0.5	1.5	0.5	0.5	0.5	1.5	0.5	0.5	1	1.5	1.5	1.5	0.5	1.5	1.5	1.5	1.5	1.5	1.5	0.5	1.5	1.5	28	666	0.03688	13
15	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	1	0.5	0.5	0.5	0.5	0.5	1.5	1.5	1.5	0.5	0.5	1.5	1.5	19	454	0.02516	22
16	0.5	0.5	0.5	0.5	1.5	0.5	1.5	0.5	0.5	0.5	1.5	0.5	0.5	0.5	1.5	1	1.5	0.5	1.5	1.5	1.5	1.5	1.5	1.5	0.5	1.5	1.5	27	638	0.03535	14
17	0.5	0.5	0.5	0.5	1.5	0.5	1.5	0.5	0.5	0.5	1.5	0.5	0.5	0.5	1.5	0.5	1	0.5	1.5	1.5	1.5	1.5	1.5	1.5	0.5	1.5	1.5	26	612	0.03388	15
18	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	40	1074	0.05949	1
19	0.5	0.5	0.5	0.5	0.5	0.5	1.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	1.5	0.5	0.5	0.5	1	1.5	1.5	1.5	1.5	0.5	0.5	1.5	1.5	22	516	0.02857	19
20	0.5	0.5	0.5	0.5	0.5	0.5	1.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	1.5	0.5	0.5	0.5	0.5	1	1.5	1.5	1.5	0.5	0.5	1.5	1.5	21	494	0.02737	20
21	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	1	1	1.5	0.5	0.5	1.5	1.5	17.5	427	0.02367	23
22	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	1	1	1	0.5	0.5	1.5	1.5	17	419	0.02322	24
23	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	1	1	0.5	0.5	1.5	1.5	16.5	410	0.02273	25
24	0.5	0.5	0.5	0.5	1.5	0.5	1.5	0.5	0.5	0.5	1.5	0.5	0.5	0.5	1.5	0.5	0.5	0.5	1.5	1.5	1.5	1.5	1.5	1	0.5	1.5	1.5	25	586	0.03247	16
25	1.5	1.5	0.5	0.5	1.5	0.5	1.5	0.5	0.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	0.5	1.5	1.5	1.5	1.5	1.5	1.5	1	1.5	1.5	34	852	0.04718	7
26	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	1	0.5	14	372	0.02059	27
27	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	1.5	1	15	386	0.02139	26
Sum																														1	-

For the construction of the priorities matrix the coefficient of advantage k_{ij}, of the element of the i^{th} row (a_i) in comparison with the element of the j^{th} column is written on the cross-section of the

row and column (a_j).

Advantage coefficients may have the values:

– 1.5 – if the in the i^{th} row has greater advantage than function in j^{th} column ($k_{ij} = 1.5 \rightarrow a_i \succ a_j$);

– 1 – at the similar significant function ($k_{ij} = 1 \rightarrow a_i \approx a_j$);

–0.5 – if the function in the i^{th} row has smaller advantage, than the function in the j^{th} column ($k_{ij} = 0.5 \rightarrow a_j \succ a_i$).

Further parameter P_i (absolute priority) is found. Parameter P_i is determined as a sum of the products of each element of vector i^{th} row on the elements of vector-column Σk_{ij}, i. e. [2, 21]:

$$\begin{aligned}
&P_1 = k_{11}\sum k_1 + k_{21}\sum k_2 + ... + k_{1j}\sum k_i + ... + k_{1n}\sum k_n;\\
&P_2 = k_{21}\sum k_1 + k_{22}\sum k_2 + ... + k_{2j}\sum k_i + ... + k_{2n}\sum k_n;\\
&.....\\
&P_i = k_{i1}\sum k_1 + k_{i2}\sum k_2 + ... + k_{ij}\sum k_i + ... + k_{in}\sum k_n;\\
&.....\\
&P_n = k_{n1}\sum k_1 + k_{n2}\sum k_2 + ... + k_{nj}\sum k_i + ... + k_{nn}\sum k_n.
\end{aligned} \quad (1)$$

Then utility coefficient λ of each function is found [1, 22]:

$$\lambda_i = P_i / \Sigma P_i \text{ if } \Sigma\lambda_i = 1. \quad (2)$$

Rank of the function is determined, depending of the value of the utility factor λ. The greater is the utility factor, the higher is the rank of the function.

Having performed the above-mentioned calculations utility diagrams (Fig. 4) and ranking diagrams (Fig. 5) of the blocks and mechanisms functions of Kalashnikov assault rifle relatively utility coefficient will be constructed.

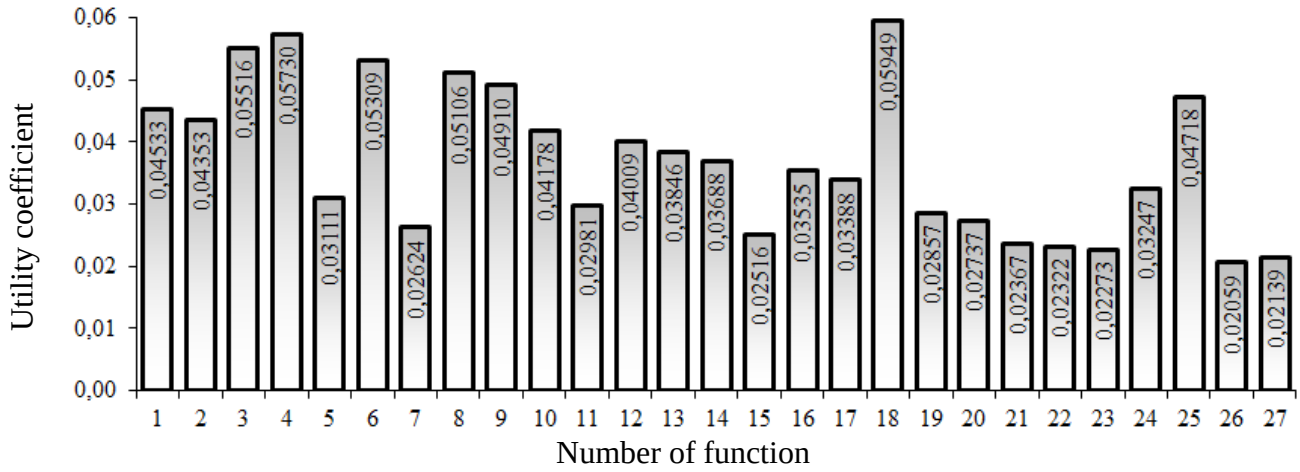

Fig. 4. Diagram of utility functions of blocks and mechanisms of Kalashnikov assault rifle

Costs in the process of functional-cost analysis act as the payment for the utility. Generalized cost criterion in the process of designing of engineering or production systems takes into account costs at all stages of the system life cycle, for their assessment matrix of costs is constructed (Table 4), cost coefficient is determined from this matrix.

At this stage the method of the expert assessments, comparison with the «ideal model», is widely used, also the significance level of each function and expenses for it are compared. For this purpose, cost factor per function is used, it is calculated by means of comparison of the parameter (function) share in the costs to its utility coefficient.

Cost factor is determined by the following formula [2, 22]:

$$K_i = \varepsilon_i / \lambda_i \text{ if } \Sigma\lambda_i = 1, \Sigma\varepsilon_i = 1, \quad (3)$$

where ε – is the share of the function in the costs.

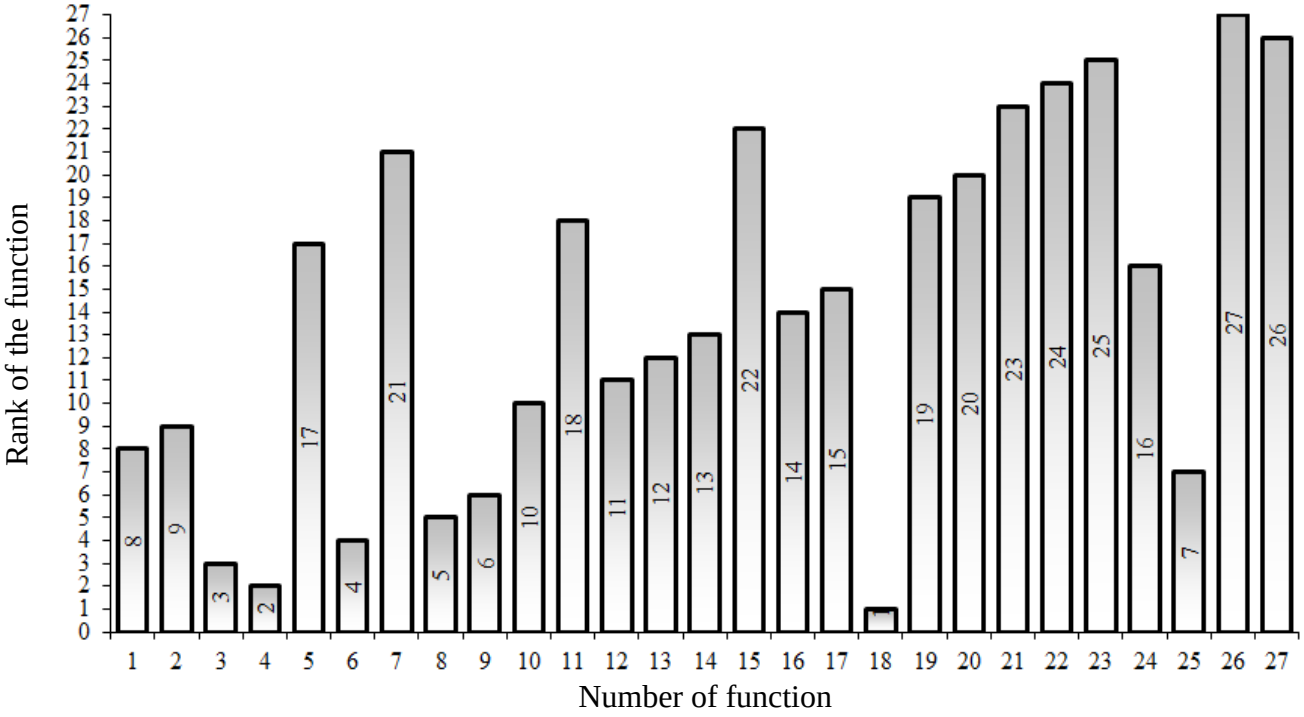

Fig. 5. Ranking diagram of blocks and mechanisms functions of Kalashnikov assault rifle relatively utility coefficient

Share of the function in the cost is determined by the formula [2, 3, 19]:

$$\varepsilon_i = \frac{B_i}{\sum_{i=1}^{n} B_i}, \tag{4}$$

where B_i – is the cost of each function; $\sum_{i=1}^{n} B_i$ – is the sum of the cost of all the functions of the system.

In theory and practice of the functional- value analysis the following criteria of the costs coefficient per function assessment are accepted [1, 3]:

– cost coefficient equals «1» or is close to one – the ratio between cost and function is justified;

– cost coefficient is less than «1» – the ratio is favorable;

– cost coefficient is more than «1» – measures should be taken, aimed at reduction of cost for function obtaining.

Specific procedure of functional -value analysis is the construction of functional-value diagrams, which are graphic representation of the ration between the utility of the functions and costs for their realization. Construction of the functional-value diagrams is performed to reveal discrepancy of the cost relatively function utility. Functional-value diagram is constructed for a group of functions, having common peak. In the first quadrant the utility or significance of the function is shown, in the second – costs for the function (Fig. 6).

Having carried out the above-mentioned computations we will construct the cost diagrams (Fig. 7) and diagrams of functions ranking (Fig. 8) of the of blocks and mechanisms functions of Kalashnikov assault rifle relatively cost coefficient.

The next stage of the functional-value analysis is the determination of functional cost index [2, 10]:

$$\Pi_{FCi} = \lambda_i - K_i. \tag{5}$$

Functional-cost index shows how much the cost portion of the operation execution or function is greater than the useful function. Values of the functional-cost indices of blocks and mechanisms of

Kalashnikov assault rifle functions relatively cost coefficient is shown in Table 5.

Table 4

Cost matrix of blocks and mechanisms functions of Kalashnikov assault rifle

№ of function	Name of the function	Частка функції у витратах	Коефіцієнт корисності	Коефіцієнт витрат	Rank of the function
1	Assembly of the parts and mechanisms of the assault rifle	0.002	0.04533	0.044	23
2	Provision of the barrel locking by the breech and breech closure	0.001	0.04353	0.023	26
3	Bullet flight direction	0.001	0.05516	0.018	27
4	Give the bullet firing velocity	0.061	0.0573	1.065	9
5	Forwarding the combustion gases from the barrel into the gas-trap piston of the breech carrier	0.091	0.03111	2.925	4
6	Targeting of the assault rifle during firing on various distances	0.052	0.05309	0.979	10
7	Prevents the pollution of the parts and mechanisms, located in the receiver	0.003	0.02624	0.114	21
8	Convenience of using the assault rifle during firing	0.102	0.05106	1.998	6
9	Breech and trigger mechanism actuation	0.011	0.0491	0.224	20
10	Seating cartridge into the barrel channel	0.015	0.04178	0.359	16
11	Bore locking	0.101	0.02981	3.388	3
12	Cartridge capsule breaking	0.101	0.04009	2.519	5
13	Extraction of the shell casing from the bullet chamber	0.011	0.03846	0.286	18
14	Turning of the breechblock carrier with the breech in front position	0.001	0.03688	0.027	25
15	Rifleman hand protection against burns during firing	0.002	0.02516	0.079	22
16	Putting trigger from cocked position or automatic cock	0.021	0.03535	0.594	11
17	Delivering a blow on barrel firing-pin	0.019	0.03388	0.561	12
18	Support of duel firing delivery	0.101	0.05949	1.698	7
19	Firing halt	0.009	0.02857	0.315	17
20	Firing prevention at open breechblock	0.111	0.02737	4.056	2
21	Putting the assault rifle on safe position	0.026	0.02367	1.098	8
22	Flame size reduction during shot	0.115	0.02322	4.953	1
23	Sound force reduction during shot	0.011	0.02273	0.484	14
24	Arrangement of cartridges and their supply into the receiver-barrel assembly	0.001	0.03247	0.031	24
25	Defeat of the enemy in close combat	0.011	0.04718	0.233	19
26	Cleaning and lubrication of the assault rifle	0.011	0.02059	0.534	13
27	Convenience of carrying arms	0.009	0.02139	0.421	15
Sum		1	1	-	-

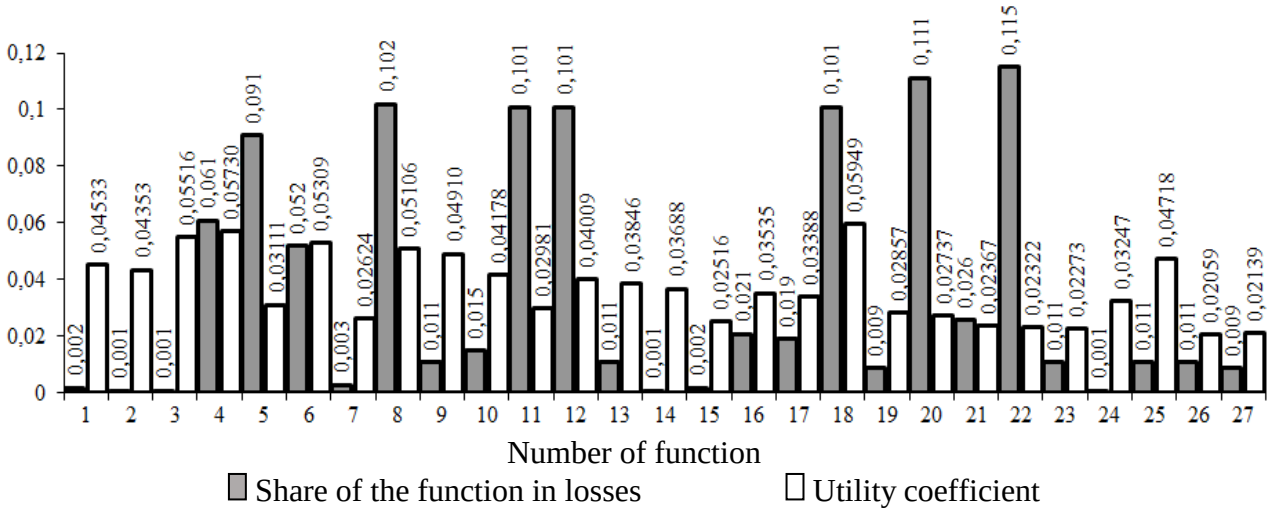

Fig. 6. Functional-cost diagram of the blocks and mechanisms of Kalashnikov assault rifle

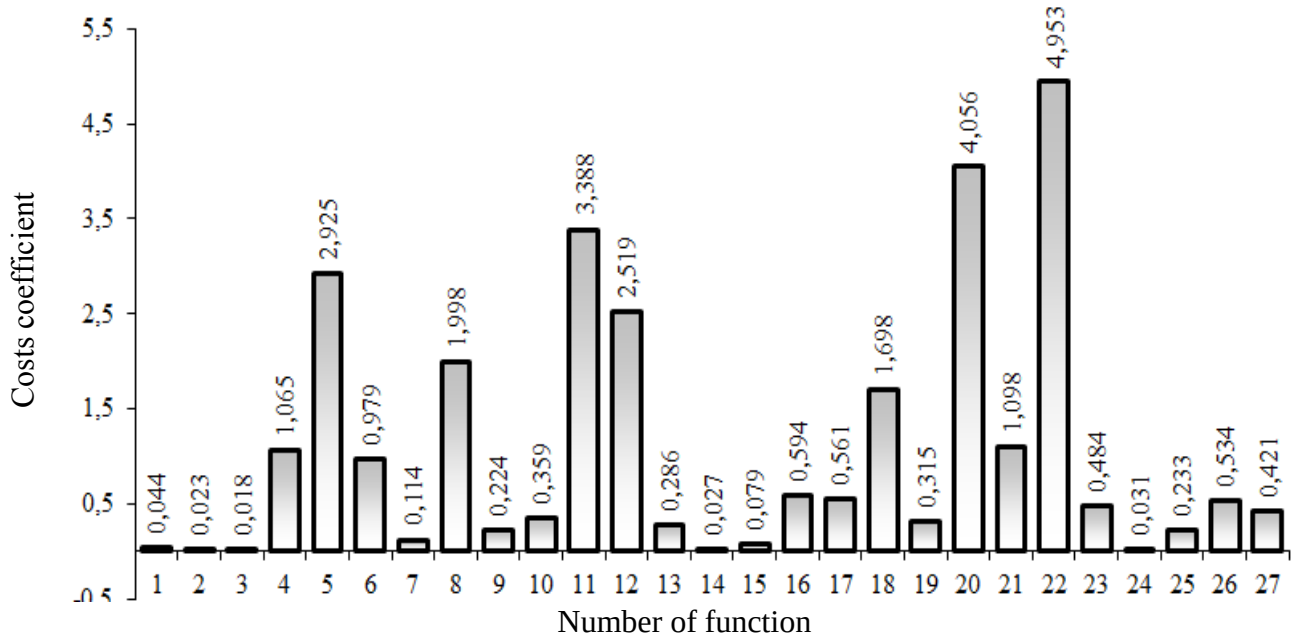

Fig. 7. Cost diagram of blocks and mechanisms functions of Kalashnikov assault rifle

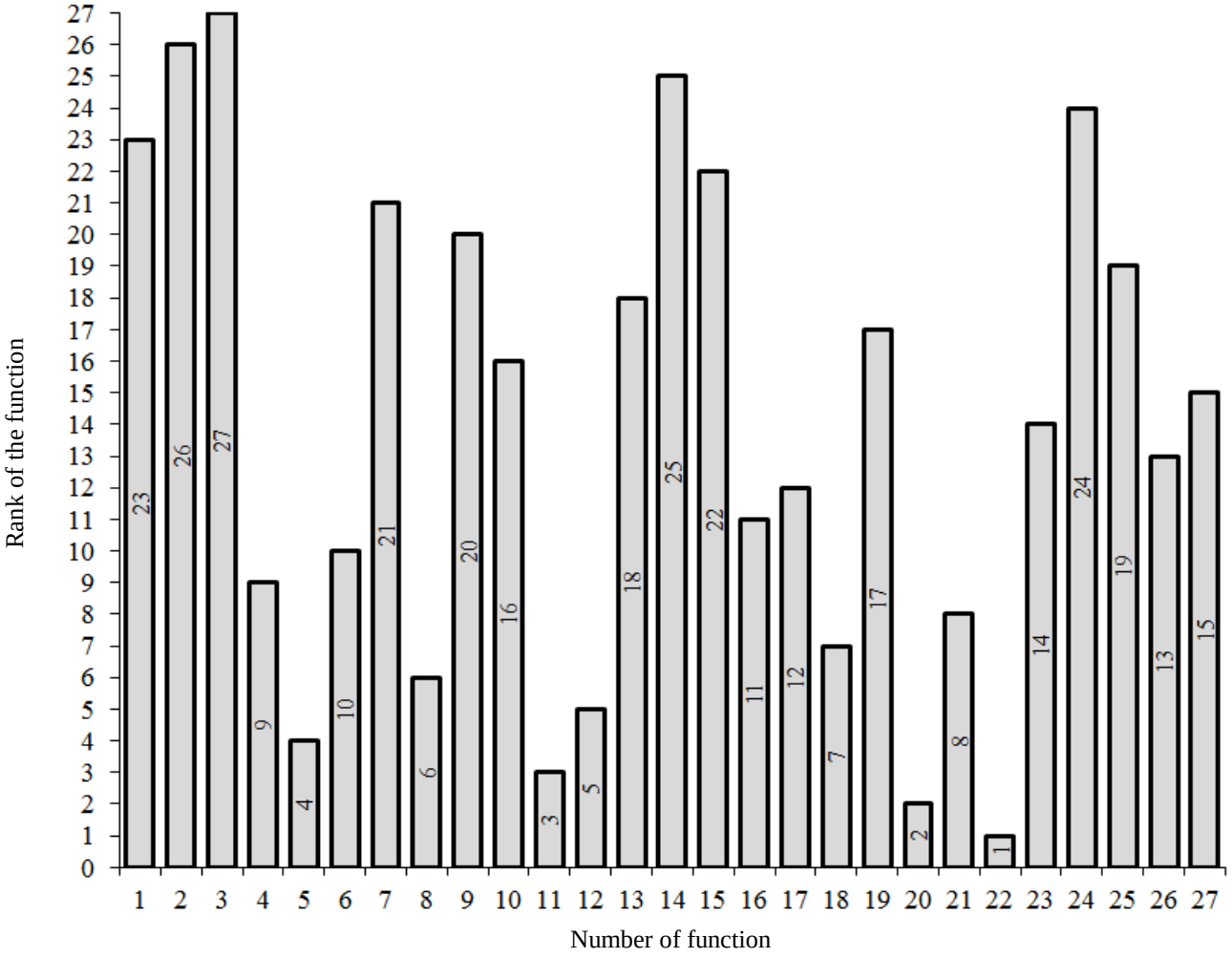

Fig. 8. Ranking diagram of blocks and mechanisms functions of Kalashnikov assault rifle relatively cost coefficient

Table 5

Values of functional cost indices of blocks and mechanisms functions of Kalashnikov assault rifle

№ of function	Name of the function	Functional -cost index	Rank of the function
1	Assembly of the parts and mechanisms of the assault rifle	0.001	5
2	Provision of the barrel locking by the breech and breech closure	0.021	2
3	Bullet flight direction	0.037	1
4	Give the bullet firing velocity	-1.007	19
5	Forwarding the combustion gases from the barrel into the gas-trap piston of the breech carrier	-2.894	24
6	Targeting of the assault rifle during firing on various distances	-0.926	18
7	Prevents the pollution of the parts and mechanisms, located in the receiver	-0.088	7
8	Convenience of using the assault rifle during firing	-1.947	22
9	Breech and trigger mechanism actuation	-0.175	8
10	Seating cartridge into the barrel channel	-0.317	12
11	Bore locking	-3.358	25
12	Cartridge capsule breaking	-2.479	23
13	Extraction of the shell casing from the bullet chamber	-0.248	10
14	Turning of the breechblock carrier with the breech in front position	0.010	3
15	Rifleman hand protection against burns during firing	-0.054	6
16	Putting trigger from cocked position or automatic cock	-0.559	17
17	Delivering a blow on barrel firing-pin	-0.527	16
18	Support of duel firing delivery	-1.638	21
19	Firing halt	-0.286	11
20	Firing prevention at open breechblock	-4.028	26
21	Putting the assault rifle on safe position	-1.075	20
22	Flame size reduction during shot	-4.929	27
23	Sound force reduction during shot	-0.461	14
24	Arrangement of cartridges and their supply into the receiver-barrel assembly	0.002	4
25	Defeat of the enemy in close combat	-0.186	9
26	Cleaning and lubrication of the assault rifle	-0.514	15
27	Convenience of carrying arms	-0.399	13

From economic point of view it is expedient to develop functions with positive functional cost index.

Having performed the above-mentioned calculations, the diagrams of functional-cost indices values (Fig. 9) and ranking (Fig. 10) of blocks and mechanisms functions of Kalashnikov assault rifle relatively functional cost index will be constructed.

Functions, having positive functional-cost index and the highest rating of the considered functions are determined by the diagrams (Fig. 9 and 10). Operations or functions, having the largest functional-cost index and rank leads to further development of the system or achievement of

the analysis aim.

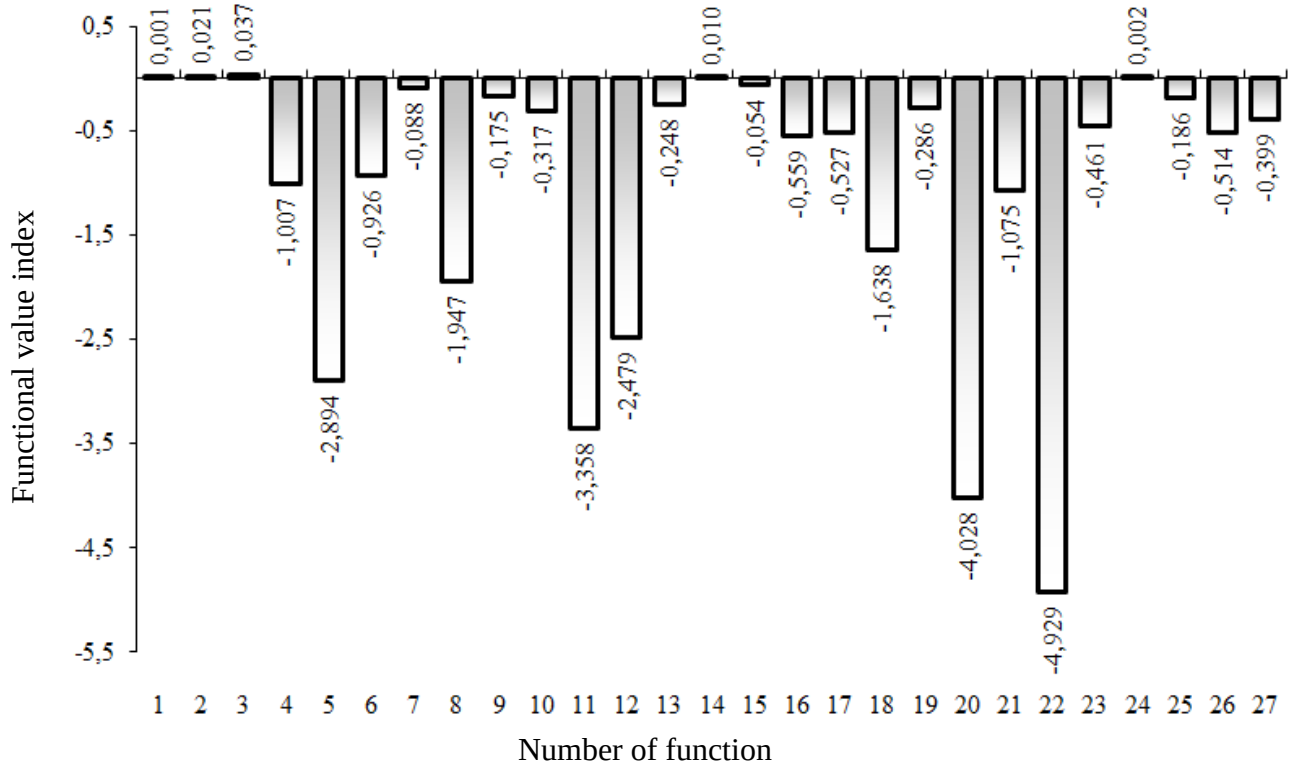

Fig. 9. Diagram of the index of functional cost values of blocks and mechanisms of Kalashnikov assault rifle

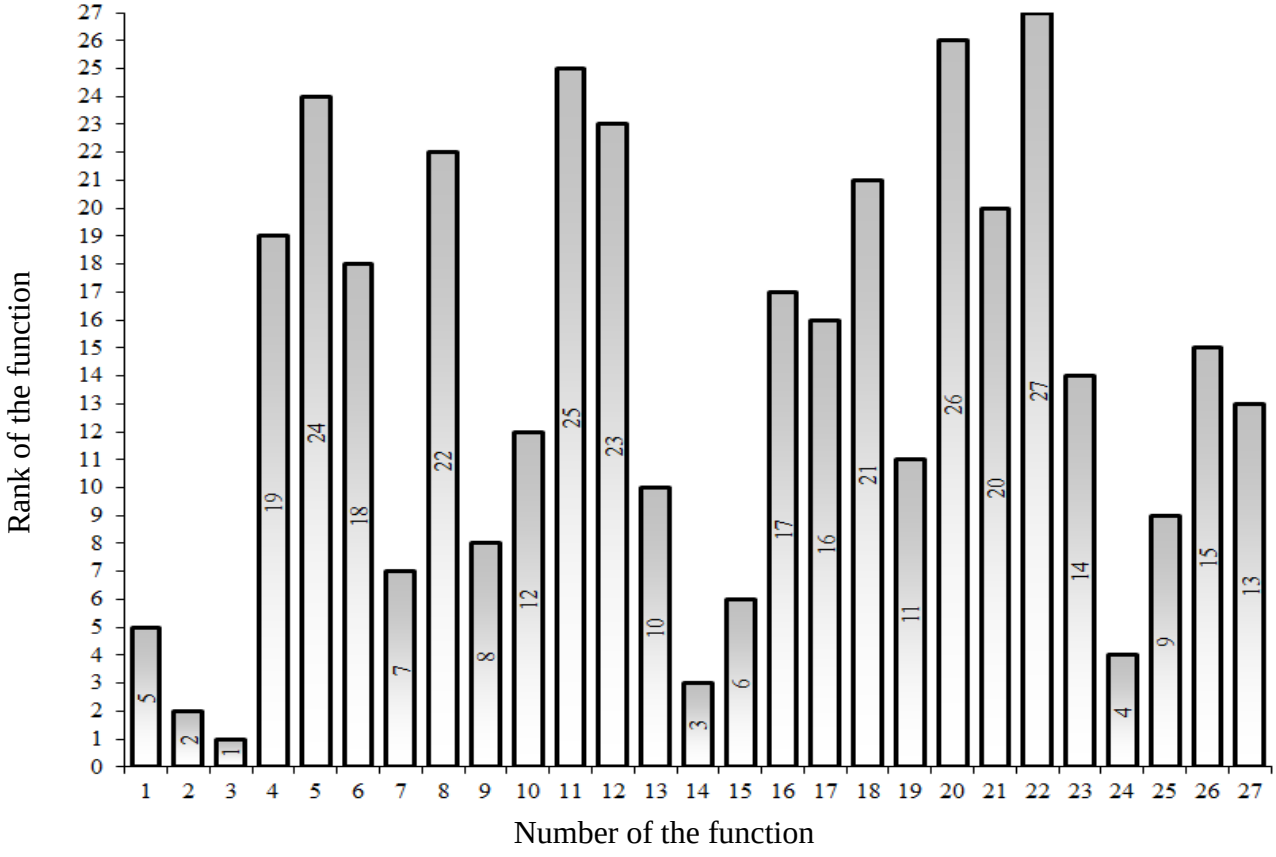

Fig. 10. Ranking diagram of blocks and mechanisms functions of Kalashnikov assault rifle relatively functional-cost index

Conclusions

1. Functional cost analysis of blocks and mechanisms of Kalashnikov assault rifle carried out, showed that function №18 «Provision of automatic or single fire» has the highest rank and greatest functional-cost index, the basis of the function is main task of the developed technical system.

2. By the results of calculation of functional-cost indices of the blocks and mechanisms of Kalashnikov assault rifle the conclusions can be made that functions №2 «Provision of the barrel locking by the breech and breech closure» and №3 «Bullet flight direction» are the functions, improvement of which leads to further development of the system.

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