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ECONOMIC EFFICIENCY OF CONSTRUCTION MACHINERY IN CONSTRUCTION

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ABSTRACT

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GENERAL CHARACTERISTICS OF WORK

Relevance and development of the topic. In a market economy, the issue of selecting appropriate machines and mechanisms with high economic characteristics for the construction industry is of great importance.

This applies above all to the production of high quality construction materials with the help of construction machinery and equipment, which are distinguished by their high productivity, low energy and fuel consumption, low operating costs, high reliability, the ability to replace several machines and mechanisms currently used in construction.

The study of the strategy for the selection and operation of construction machinery is primarily related to the construction production technology, which is related to the destination of the relevant construction object and the methods of construction work on its implementation with the necessary equipment.

The Strategic Roadmap for the Development of Heavy Industry and Machinery in the Republic of Azerbaijan states that the policy of providing the necessary financial and technological support to business entities operating in the sector will be continued to achieve the set goal. Financial incentives for investment in heavy industry and engineering will be provided to participate in the global value chain, venture investments will be attracted to the authorized capital of industrial companies, local enterprises will be provided with basic materials at competitive prices, and various tax incentives will be applied.

Heavy industry and machine-building enterprises in Azerbaijan have strong potential to support import substitution activities. In this regard, the Decree of the President of the Republic of Azerbaijan No. 1046 of September 15, 2016 "On additional measures to increase the efficiency of procurement in the activities of executive authorities and organizations financed from the state budget" will have a significant impact on increasing demand for local engineering products.

The issues of improving construction production are directly related to the choice of machines and mechanisms that make it possible to increase the speed of the construction production process, reduce construction time, reduce the number of personnel directly involved in the construction

process, improve all economic indicators that ensure high profitability and profitability of the construction enterprise in the process of construction production.

After gaining independence, the Republic of Azerbaijan has been carrying out large-scale construction and reconstruction of industrial facilities, socio-cultural facilities and housing, as well as transport systems communications, including highways, railways, airports, sea terminals and railway stations.

The current scale of capital construction requires a perfect technical structure that ensures the economic advantage of the construction industry, helps to expand its production, improve the quality and cost of construction materials and construction work, and shorten the construction period. The main component of this is the complex mechanization of construction and installation work.

As can be seen, mechanization is becoming one of the main ways to improve the economic performance of labor-intensive construction and installation work. The main task of scientific research in recent years is to complete the complex mechanization of construction of buildings, main pipelines, railways and highways, airports, power transmission and communication lines, as well as other facilities.

Entrepreneurs operating in the field of construction business pay special attention to improving the economic characteristics, technical and organizational level of operation of construction machines and their sets.

The need for a comprehensive study of the economic efficiency of construction machinery at different stages of the construction process, as well as the validity of the idea of choosing construction machinery based on its technical and economic characteristics, determined the relevance of the dissertation topic.

Research shows that the degree of scientific development of the problems of economic efficiency of the application of construction machinery and equipment in construction work has taken a certain place in the scientific research of Azerbaijani scientists as A.M. Aliyev, K.A. Aliyev, A.B. Aliyev, A.R. Sharifov, M.A. Hajiyev, Kh.M. Yahudov, S.G. Jumshudov and others and continues to do so today.

At the same time, the works of foreign scientists, as L.I. Viger and R.N. Kolechayev, have made a great contribution to the theoretical basis of

the formation of the fleet of construction machinery and increase its economic efficiency in the field of modernization of the fleet of construction machinery, in the field of service life optimization - R.M. Petukhov, A.I. Veger and others,

in the field of economic efficiency of application of construction machines - S.I. Abramov, V.I. Balovnev, M.I. Griff, Y.N. Zaytsev, S.Y. Conterer, A.P. Kovalyev and others, in the field of ensuring the efficiency of construction machinery - O.A. Bardishev, V.A. Zorin, B.Q.Kim, Y. A.Koritov, İ.A.Luyk, S.N.Nikolayev, S.Y. Maksimova, S.V.Renin and others.

The author's experience of direct participation in the development and application of a reasonable strategy for the application of construction machinery in construction works provides a basis for scientific and practical proposals on the real increase in production capacity of the construction industry and its economic efficiency.

Object and subject of research. The object of research is the application of construction machinery in the field of construction as one of the main factors in ensuring the sustainable development of the national economy. The subject of the research is the development of a substantiated strategy for the application of construction machinery in the field of construction and the economic conditions that promote the economic efficiency of construction production.

Goals and objectives of the dissertation. In order to achieve the purpose of the dissertation, the following tasks are identified:

- assessment of the demand of the construction object for various construction machines and their economic viability;
- substantiation of economic expediency of purchasing construction machines for the service life in accordance with the needs of the construction site;
- development of a model for optimizing the process of forming a fleet of construction machinery with a defined production capacity with minimal capital investment;
- economic assessment of the construction site's need for repair capacity to ensure the stable operation of the formed construction machinery fleet;economic substantiation of application of machines and mechanisms in construction;

- economic justification for the use of construction machinery in construction;
- calculation of cost and common size of capital investment to determine the comparative economic efficiency ratio of additional capital investments when comparing the two options;
- calculation of economic efficiency, defined as the difference between the total costs incurred in the relevant volume of work during the selection of mechanization options;
- determination of productivity of construction machines involved in the construction of a specific construction object;
- calculation of annual production of construction machinery involved in the construction of complex facilities;
- calculation of capital investments in machines with different service life, together with the determination of the cost group of machine-hours;
- determination of the average operational productivity of the machine per hour at the facility during the year;
- calculation of economic efficiency, determined by the method of differences of incurred costs, calculated not at cost, but at book value;
- calculation of economic efficiency in the construction of new machines and mechanisms.

Research methods. The economic efficiency of construction machinery used in various fields of construction is to distinguish the economic methods and techniques of selection of construction machinery, taking into account the design, technical and operational characteristics of the construction object.. This requires a methodological approach to the research method of the dissertation, ie a problem-based approach to the economically justified selection of effective means of mechanization that provide a comprehensive solution to the necessary construction tasks and increase labor productivity at the lowest cost of operation with construction machines.

The main provisions of the defense:

The choice of construction machinery and mechanisms based on the technical, production and operational characteristics that fully meet the requirements of the construction organization during the construction of

construction facilities, the economic and production characteristics of the application:

- methods for calculating the economic efficiency and evaluation of key indicators of construction machinery and equipment in construction, ensuring the efficiency and quality of the construction process;
- it is necessary to study the methods of determining the productivity of construction machinery and mechanisms involved in the construction of facilities, taking into account the design features and technical advantages;
- depending on the nature and purpose of the construction work performed, it is necessary to determine the validity of the calculations showing the economic efficiency of determining their area of application, based on the experience of using construction machinery during construction;
- there is a need to study the methods of assessing the economic efficiency of new machines and mechanisms that help increase labor productivity in construction, reduce the cost of construction products, as well as the calculation of the economic efficiency of new machines and mechanisms in construction;
- methods developed for the selection of optimal solutions in the field of mechanization in construction with the application of mathematical methods and the optimal composition of the fleet of construction machinery should be calculated and proposals should be prepared.

The scientific novelty of the research is based on the effectiveness of technical operational characteristics, for the first time in the country to justify the selection and operation of relevant construction machinery and equipment, as well as the implementation of comprehensive economic research on costs in general:

- depending on the purpose and nature of the construction work performed, economically justified tendencies for the formation of various construction machines have been identified;
- methods for calculating the economic feasibility of purchasing construction machinery, taking into account technical and operational productivity, have been developed;

- calculation methods have been developed to assess the feasibility of purchasing construction machinery from a technical and economic point of view;
- economic assessment of the model of formation of the fleet of construction machines was calculated depending on the volume and nature of work performed by construction organizations;
- the level of financial costs for the permanent maintenance of construction machines and mechanisms through the formation of repair forces was studied;
- the economic efficiency of new machines and mechanisms used in construction was assessed;
- the economic efficiency of the modernization of construction machines carried out in the process of operation at construction sites has been determined;
- the method of economic expediency of service life of construction machines taking into account physical wear has been determined;
- Optimal economic decisions in the field of mechanization of construction with the application of mathematical methods have been developed and proposals have been put forward.

Practical significance of research. The practical significance of the work is due to the fact that construction companies, depending on the nature of future construction work, develop a methodology for selecting and forming an appropriate fleet of construction machinery for them, taking into account theoretical calculations to determine technical, production and operational characteristics**.**

Approbation and application. The author has published 12 articles in scientific journals recognized by the HAC, including 5 published abroad and presented at international conferences.

The results and recommendations of the dissertation were accepted for use by "AzVirt" LLC.

The main provisions and results of the dissertation were published in the monograph "Selection of construction machinery and economic features of its application in construction."

The organization where the dissertation work is carried out is the Department of "Organization and Management of Industry" of Azerbaijan University of Architecture and Construction.

The structure and total volume of the dissertation. The dissertation consists of an introduction (16220 characters), 3 chapters (Chapter I - 50207, Chapter II 67388, Chapter III 85094) and conclusion (5375). The total volume of the dissertation, except for the list of references, appendices, tables, pictures and graphics, is 208064 characters.

THE MAİN CONTENT OF THE RESEARCH

In the introduction of the dissertation the relevance of the topic, the purpose and objectives of the research, the subject, the main provisions of the defense, the state of the problem, the scientific novelty and practical significance of the research, the approbation of the work are explained and justified.

In the first chapter of the dissertation titeled "The role of construction machines and mechanisms in production and productivity" the economic efficiency of the use of construction machines and mechanisms in construction work is considered, the calculation of the efficiency of investments in construction is carried out, the comparative economic efficiency of the use of construction machinery and equipment in construction work was calculated by comparing various options, as well as comparing new solutions with those that were applied in practice in similar situations, or with those that were adopted in projects and samples. Studies have shown that as one of the indicators for assessing the effectiveness of mechanization in the preparation of estimates, unlike the accepted system of calculating additional costs as a percentage of direct costs in calculations, the cost of mechanized work should be calculated, additional costs as a percentage of operating costs and as a percentage of labor involved in mechanized processes, as well as manual labor.

Methods for determining the productivity of machines and mechanisms in the construction process, as well as factors affecting their parameters, design features and technical condition were studied. General additional indicators that characterize the efficiency of the machine also include: the degree of relief and improvement of working conditions of employees, the degree of mobility and versatility of machines, ease of

starting and operating machines, and so on. Figure 1.1, developed by the author, shows the scheme of the system of basic and additional indicators.

An indicator that characterizes the degree of simplification and rehabilitation of workers involved in the technological process is crucial in cases when there are harmful conditions for the health of workers in the production, accidents or overexertion of workers. Examples include loading and unloading cement, chalk, lime and other materials, slaking lime, mining in mines (the possibility of subsidence), rock explosion and other technological processes. Most of the additional indicators are characterized by the simplicity of calculating the quantities, which allows them to be used for an initial assessment of the proposed design solutions at the design stage of new machines, as well as for the initial determination of the machine set when choosing options for mechanization.

The degree of efficiency of mechanized work and the quantities of their performance are significantly affected by the conditions of physical and mental wear of machines and the service life determined by a number of other factors. Attention should be paid to the correct selection of the unit of measurement in order to be able to make a perfect comparison of the proposed options of mechanization in terms of quantities of basic and, in part, additional indicators.

Key indicators determined by calculation often give different estimates of the effectiveness of comparable mechanization options. In this regard, there is a need to determine the values of aggregate indicators by comparing different indicators and a comprehensive assessment, which allows to reasonably address the issue of the amount of economic effect provided by the degree of efficiency of one or another option and the application of the best option.

There is a greater need to compare cost and capital investment. If one of the considered options provides a lower cost of the product or unit of work compared to the other option (usually the reference option), but also requires a large amount of special capital investment, then such a comparison is made [64, p. 59,60].

When comparing the two options, the following formula calculates the coefficient of comparative economic efficiency (E) of the additional capital investment (or cost of additional fixed assets) required for the option with the largest capital investment compared to the second:

$$E = \frac{M_v'' - M_v'}{K_x' - K_x''}, \qquad (1)$$

Here M_v' və M_v'' – unit cost of products for options I and II (man / u); K_x' və K_x'' – special capital investments on options I and II (man / u / year); E is the comparative economic efficiency ratio. Hereinafter, this ratio will be called the "comparative efficiency ratio".

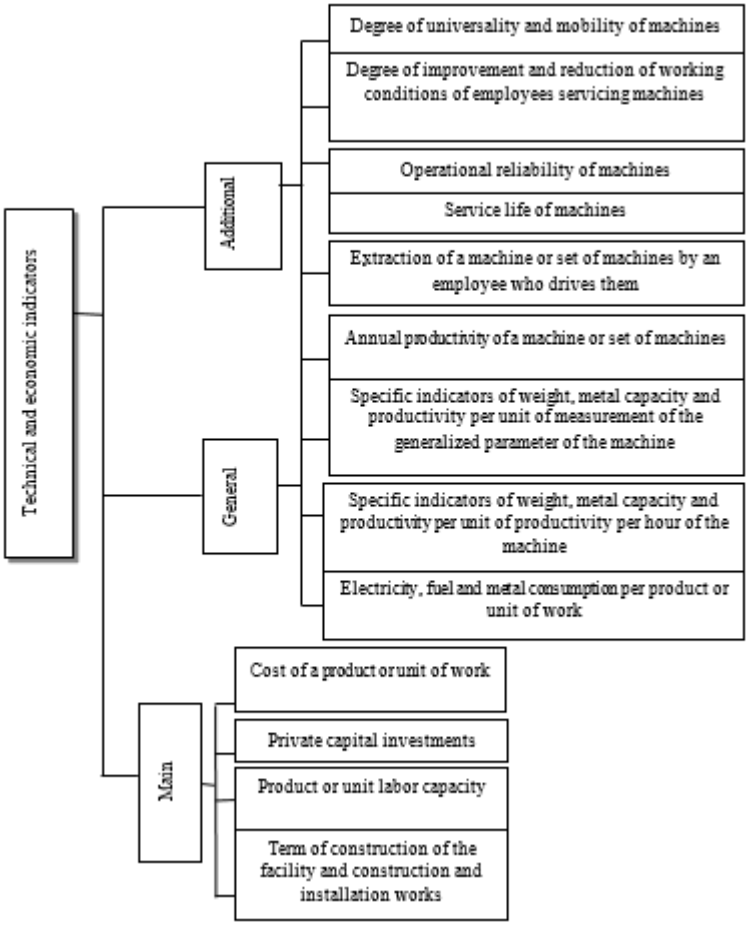

Figure 1.1. System of main and additional indicators

The application of the generalized "calculated price" indicator in the calculation of economic efficiency provided by improving the quality of

machines allows to obtain an objective and accurate price in all cases, especially in cases where the price of a better machine and the cost of its product increase, and at the same time reduces labor costs associated with the operation of machinery and equipment. According to the research, depending on the nature of the measures, the calculation of economic efficiency is performed according to different units of measurement and the following volumes of work:

1) when selecting mechanization options - for the total volume of mechanization per unit of final product;

2) when assessing the effectiveness of the introduction of new types of machines and the modernization of existing ones - for the annual work of one new or one modernized machine;

3) for the purchase of machines, technical and organizational and other measures to increase the level of mechanization, when determining the effectiveness of capital investments - for one year after the implementation of the measure;

4) during the assessment of annual and long-term plans for the application of mechanization - for one year and for the perspective period.

The impact of machines and mechanisms on productivity is determined by the following factors:

– parameters, design features and technical conditions of machines;

– professionalism of workers operating machines and mechanisms, the ability to fully use all the parameters and design features of machines (replacement of working movements, capacity, lifting capacity), the ability to provide the necessary maintenance of machines and mechanisms;

– the type of machine-made product, the nature of the materials and structures processed and transported by the machine, the type of structure used in the construction of the machine or set of machines;

– production conditions: for excavators - height of drilling and holes, working on the vehicle or removal;

– for cranes - installation from the vehicle or warehouse, placement of prefabricated elements in the object warehouse, etc .;

– the nature of the organization of related processes and construction as a whole;

– shift and mode of operation of the machine during the year, depending on the listed factors.

During the operation of machines and mechanisms, various breaks occur during their use.

Depending on the reasons, breaks can be divided into the following groups:

I - structural and technical breaks depending on the construction of the machine, maintenance and scheduled repairs, replacement of worn equipment and rigging tools, as well as worn-out accessories (cables, conveyor belts, etc.), depending on its technical readiness for operation;

II - the organization of work and rest by the machinist, acquaintance with the drawing of the construction object and the project of execution of works, preparation of necessary documents and assignments for work, handing over the queue, rest and personal needs;

III - irreversible breaks or technological breaks in the operation of the machine and in the performance of the main production functions determined by the technology of its construction process. Time spent on the movement of machines within the work area (excavators - along the drill, cranes - from one position to another); breaks in the operation of the excavator due to the removal of stuck soils, etc .;

IV - breaks due to meteorological reasons due to the impossibility of using this or that machine during rain, strong winds and snowstorms, as well as in severe frost and heavy foggy weather;[4]

V - breaks due to organizational reasons, which are of two types, depending on the nature of the reasons.

The first is breaks that do not depend on construction management, such as the shutdown of electric vehicles due to an accident at a district power plant or damage to a feeder.

The second type of breaks is breaks determined for reasons that depend on the administrative and technical staff of the construction.

In the second chapter **"The calculation of economic efficiency indicators of machines and mechanisms applied to production activities"** the calculation of economic efficiency indicators in the construction of modern machines and mechanisms was carried out. Capital investment, as well as economic time difference in the operation of construction machinery and equipment were considered. The economic efficiency of machines and mechanisms in the construction industry has been determined.

Research shows the need for economic calculations to determine the efficiency of the use of machinery and equipment for construction work.

The effectiveness of the economical choice of machinery and equipment required for construction work has been studied.

Studies show that if the considered options of mechanization require different time investments in the purchase of mechanization tools or the construction of ancillary facilities (overpasses for cranes, etc.), then these investments are brought to the initial stage, as a rule, over time.

The total amount of capital investments brought to the initial period ($C_{br.}$) Is determined by the following formula:

$$C_{\text{br}} = \sum_{i=1}^{n} \frac{K_i}{(1+\text{E}_{\text{g.n}})^{t_i}}, \qquad (2) \qquad [38, p.112]$$

Here K_i –the cost of mechanization (periodically acquired or part of the existing fleet) involved in the production process periodically through separate sections of time, if the number of such involved is equal to n; $E_{g.n}$ – norm of import of various time expenses, accepted equal to 0.08; t_i – the time interval measured in years between the moment the next machine (or group of machines) joins the mechanized process and the delivery period.

When comparing newly purchased and standard machines with different service lives, it is necessary to invest in future years to obtain additional sets of machines with a short service life and to bring it to the capital investment in the year of purchase of the first machine. Since the annual productivity of newly acquired and reference machines is usually different, it is better to deliver on time not on the basis of the total capital investment in the purchase of the machine, but on the basis of the specific capital investment determined by formula (2.1).

Costs of operating machines can be calculated for specific conditions of use of machines by linking them to a particular construction site and the facility being built there, as well as for average operating conditions of machines without linking them to a specific construction site.

In relation to certain production conditions, the cost of calculated machine hours is used to plan the activities of a construction organization and determine the actual costs of operating the machine.

The calculation of the cost of machine-hours, designed taking into account the average conditions, is necessary to determine the estimated cost of construction. Accordingly, they distinguish between production

calculations of the cost of a machine-hour, taking into account certain specific conditions of use of machines, and estimates compiled taking into account the average conditions of use of machines.

Since the cost of the machine-hour reflects the average conditions of use of the machine, its determination is based on the averages of distances and methods of transporting the machine, the number of working hours of the machine on the site during the year, and so on.

Research shows that the annual costs of operating the machines help to determine the average cost of the unit of work performed compared to the annual production, as well as the amount of special costs incurred in the performance of this or that work with different types and types of machines of the same purpose. For machines that do not have a design-calculated hourly productivity in their passport, for example, excavators, loaders, etc., technical productivity must be accepted for 1 hour of clean work. They also calculate the performance in this case by applying the same conditions to both of the more commonly compared machines.

For comparison of cranes on specific indicators calculated per unit of productivity, it is expedient to take constructive-calculated productivity on the basis of these indicators. In order to compare cranes according to specific indicators calculated per unit of productivity, it is expedient to base these indicators on design-calculated productivity expressed by the number of cycles of lifting the load to one or another height, without taking into account manual labor costs and taking into account the 90 ° rotation of the hook.

When determining the specific parameters for the generalizing parameter, it is important to choose a technical parameter that better describes the production capacity of the machine, as well as its operational quality. It is also necessary to take into account the type of machine and the characteristics of the work it performs.

The analysis shows that knowledge of the effective application of machinery facilitates the development of long-term plans for the provision of construction machinery and the development of machinery required for construction, as well as determining the optimal structure and composition of construction machinery fleets of territorial construction organizations and specialized construction organizations.

The following options are available for the coordination of competing machines, on the basis of which the effective field of application is determined:

a) from the same type of machines forming a single parametric series, for example, universal single-axle excavators (differing in the capacity and movement equipment), scrapers (trailers and semi-trailers with different capacities), bulldozers of different power, etc.

b) from different types of machines or sets of machines performing homogeneous work. Examples include dump trucks and competing single-track excavators, which work in conjunction with self-propelled scrapers to dig pits, pour or dump soil.

In general, in the case of a reduction in the construction period of an object due to complex mechanization and the calculation of the amount of additional costs as a percentage of direct costs, additional costs are reduced by:

– reduction of labor capacity by 0.6 manat per 1 labor / day of saved labor costs;

– decrease in the salary fund by 15% due to the amount of salary savings as a result of shortening the work period;

– reduction of the conditional-fixed part of additional costs decrease in the amount of $Q_{c.f.c.}$ determined by the following formula

$$Q_{c.f.c.} = M_{o.ec} K_{əh.m} Ə_{ə.x} q_{y.п} (1 - T/T_n), \quad (2.3.3) \quad [67, s. 38]$$

Here $M_{o.ec}$ – estimated cost of the object in terms of direct costs; $Ə_{ə.x}$ – coefficient of general construction overheads; $K_{əh.m}$ – the share of wages in direct costs and in the cost of operating machinery; $q_{ş.s}$ – the share of the conditional fixed part in the additional costs; T – the actual or project construction period of the facility; T_n – normative term of object construction.

In the third chapter "Assessing the cost-effectiveness of new machinery and equipment in construction" the methods of calculating the economic efficiency of the construction of new machines and mechanisms are considered and relevant recommendations are given. At the stage of creation of new machines and mechanisms intended for the construction site, the essence of calculating their economic efficiency was revealed.

The expediency and cost-effectiveness of the modernization of machines in the process of operation were studied, which is determined first by their annual work, and then by the end of their service life.

The service life of construction machines has been determined to be economically feasible, taking into account physical and moral wear and tear.

The service life of the machines was compared taking into account various factors and determining the optimal service life.

The method of selection of decisions in the field of mechanization in construction through the application of mathematical methods was studied, the essence of the model and methods of solving the problems of optimal planning of the application of machines and mechanisms in construction were revealed. The study of the features of multi-stage solution of the issues of development of car parks has been carried out, which should be addressed taking into account the development dynamics of construction.

Taking into account the characteristics of the construction work carried out at the construction sites, the issues of optimal distribution of the car fleet on construction sites were considered.

The calculation of the optimal composition of construction machines was carried out taking into account the characteristics and scope of the construction work. When evaluating the cost-effectiveness of creating a new type of machine, they adopt the latest machine of a similar design, developed in the project, tested with test samples and recommended for use. In the absence of such test samples, and in the serial production phase, they accept the most advanced domestic or foreign machine produced in series as a standard.

The economic effect of the creation of a new type of machine is determined first by the operation of a new machine for a year, and then by its entire service life.

$$E_{il} = M_{il.y}\left[\left(D_{i.v} + K_{x.i}E_y\right) - \left(D_{y.v} + K_{x.y}E_y\right)\right], \quad (4)$$

Here $M_{il.y}$ – is the annual productivity of the new machine.

The other symbols correspond to the symbols in formula (1.11).

The total economic effect for the entire service life of the machine is determined as follows:

$$M_{məc}\sum_{t=1}^{T_x}\left(G_{et.x.x} - G_{y.x.x}\right)M_{y.m.il}B_t - K_{y.əl}, \qquad (5)$$

Here $G_{et.x.x}$ и $G_{y.x.x}$– Special expenses on standard and new machines in *t* year, *man/un, pr/year*; $M_{y.m.il}$– annual operational productivity in the *t*-th year of operation of the new march, *pr/un*; B_t–the economic effect obtained in the *t*-th year is the coefficient of bringing the new machine to the 1st year of operation,

$$B_t = \frac{1}{(1+E_{нп})^{t-1}}; \quad (6)$$

$К_{y.əl}$– Additional capital investments (ie, incurred costs) related to a new machine that are not included in the price of the machine and cover the costs incurred in scientific research, design work, development and testing of experimental samples, production preparation and development, etc. $К_{y.əl}$ is determined by this formula, taking into account the partial reimbursement of these costs due to allocations from the cost of the series product to the fund of new equipment.:

$$К_{y.əl} = \frac{К_y}{\sum m} - \frac{100 M_{y.m.h} A_{y.t.f}}{100+O_{y.t}} (1 + E_y)^{0,5 t_{yb}}, \quad (7)$$

Here K_y – the total cost of creating and mastering the production of a new machine; $M_{y.m.h}$– the cost of developing a new machine, *man.*; $A_{y.t.f}$ – allocations to the fund of new equipment, %; $\sum m$ – the total volume of planned production of new machines, *man.*;t_{yb}– years from the design of a new car to the beginning of the 2nd year of its serial production. Let's consider methods of calculation of cost-effectiveness of application of new types of machines in construction.

When calculating the economic efficiency provided by the application of new types of machines as a standard in construction, the following is accepted:

- similar to general-purpose machinery, which is generally used in construction or in certain types of construction;
- replacement equipment applied to a certain construction organization or construction object.

Compared to specialized machines, the evaluation of a new universal machine is carried out as follows:

a) select the appropriate specialized machines to be used as a standard for each type of work performed by the universal machine;

b) determine the annual economic effect provided by a new universal machine in comparison with each of the specialized machines (with the help of "plus" and "minus" signs);

c) determine the percentage distribution of annual operating time for the new machine by type of operation, taking into account the design and technical area of application;

d) taking into account the established economic effect obtained from the application of a universal machine in all types of work.

In case of modernization due to special allocations and related increase in the book value of the machine (see formula 3.9), depreciation amounts for the initial period (T ') will not be included in the budget ($K_{d.edm}$) until the modernization of the machine, the amount of which is determined by the following formula:

$$K_{d.edm} = \frac{D_{mod} N_{a.b} T'}{100}. \quad (8)$$

This amount should be applied to capital investments determined by formula (8) for a modernized machine. If a modernized machine is compared with a new local machine, then there are differences in the service life of the modernized machine (T_m), calculated from the moment of modernization of the new machine (T_y).

If the standard service life of the base machine and the new machine is the same (T_b=T_y), then the service life of the modernized machine will be less than T' 'years of service life of the new standard machine (T_m=T_y–T').

In the case of different service life of the compared machines, it is necessary to bring the capital investment in these machines closer to the same period of their use. Suppose a new standard machine is used in an organization for up to a year of use of the retrofit machine (T_m), after which it will be sold at its residual value. Thus, the capital investment for a new reference machine should be accounted for in the amount determined by the following formula:

$$K_{g.y.et.} = D_{y.et}\left[1 - \frac{(T_y - T_m)}{T_y(1+E_{y.g})^{T_m}}\right]. \quad (9)$$

The economic effect of the modernization of a machine is determined first by the number of years during which it has been in operation (annual economic effect), and then by the end of its service life (overall economic effect).

To determine the economically feasible service life of a machine, taking into account physical wear and tear, the average specific costs incurred during the entire service life (G_{xx}) reveal the functional dependence of the limit age determined by its service life (T). As T increases, some costs (depreciation amounts) decrease, while others (maintenance and repair costs, fuel, lubricants, and eraser costs) increase. At the same time, the annual production of the machine is reduced.[13]

As for the results of the dissertation, the dissertation explores the problem of renewal of fixed assets of construction companies in the form of construction machines and mechanisms. Research provides a good basis for the correct formulation of economic efficiency policy of construction companies on the selection and operation of construction machinery and equipment, which allows for high productivity and long-term operation at a minimum level of costs for the maintenance of these fixed assets.

The research conducted suggests that the developed and proposed methods of calculations for the modernization of construction enterprises with modern construction machinery and equipment allow to further strengthen economic activity in one of the most important sectors of the economy - the construction industry.

In the "Results" section of the dissertation, the scientific-practical suggestions and recommendations arising from the essence of the research can be classified as follows:

1. Identify general and specific indicators when evaluating any mechanization tools used in construction, regardless of their design and purpose. Such general and specific indicators include the consumption of electricity, products, as well as the consumption of fuel and metal per unit of work performed by a machine or a set of machines, specific gravity, operational reliability, metal intensity and power based on the aggregate parameter of the machine, hourly productivity, annual productivity of the machine or a set of machines, as well as productivity per machine worker per shift, service life and age, reflecting the economic characteristics of construction machines.

2. The essence of the system of main and additional indicators of used construction machines and the need to provide technical and

economic characteristics of construction machines, reflecting their impact on the cost of the main construction product in the market.

3. The proposed methods of calculating the generalized indicator of economic efficiency and book value, provided by improving the quality of machines, in all cases, especially in cases where the price of a better machine and the cost of its product increase and labor costs associated with the operation of machinery and equipment decrease, allow to obtain an objective and accurate assessment.

4. Methods for determining the productivity of machines and mechanisms in construction have been developed, which are also affected by: parameters, design properties, technical condition of machines, professionalism of workers, proper maintenance of the machine, type of product produced by the machine, production conditions, the nature of the organization of mixed processes, the queues of the machine and the mode of operation during the year.

5. The classification of types and norms of design-calculation, technical and operational productivity of construction machines has been studied, which provides a basis for a more economically correct choice of construction machines and mechanisms for production. Naturally, this, in turn, will help improve the quality and quantity of construction products, as well as reduce the amount of manual labor.

6. Annual costs for the operation of construction machinery, including a set of monetary costs per machine-hour per hour, one-time costs, including one-time costs of bringing machines to the construction site, its installation, testing and dismantling; and, if necessary, dismantling of ancillary facilities; relocation of self-propelled vehicles within the construction area; amortization funds, as well as the calculation of the cost of maintenance and repair of auxiliary facilities, ie roads for self-propelled vehicles within the working zone of the construction during the year.

7. Based on the estimated norms of labor costs, the method of calculation of mechanized works and its comparison with planned norms, as well as determination of unit cost of mechanized works, unit labor capacity, electricity and fuel consumption per unit of final product were performed in accordance with the research.

8. Research has been conducted to determine the effectiveness of the use of machinery and equipment for land, concrete, installation,

finishing and other construction work without transport operations related to the transportation of materials and structures outside the construction work area.

9. A methodology for assessing the economic efficiency of new machines and mechanisms has been developed by creating a new machine that provides replacement of several specialized machines and can be used in various construction works and calculating the economic efficiency depending on the cost of its use in construction.

10. A graphical method for determining the economic feasibility of machine service, taking into account the specific costs incurred due to physical wear and service life over the years, as well as a graphical method to determine the economic feasibility of service life of machines used in construction, taking into account wear and tear.

11. A system for selecting optimal solutions through the application of mathematical methods in the field of mechanization in construction has been developed. With the help of this, economic calculations are performed using modern computational techniques that help to solve the problems of perspective and medium-term planning of development trends of construction mechanization on the basis of informative statistical modeling, which allows to predict the future development of construction machines and mechanisms.

The main provisions of the dissertation are reflected in the following scientific articles and applied in AzVirt OJSC:

1. Ahmet Alpaslan Mehmet Nusret . "Methods of calculating the economic efficiency of new machines and mechanisms for construction" Scientific works №4,2015, Institute of Economics of ANAS Baku 2015, p.77-85;

2. Ahmet Alpaslan Mehmet Nusret. Calculation of economic efficiency and the number of indicators of machines and mechanisms "Economics and management in machine building" №4 2015, Moscow, p. 16-19;

3. Ahmet Alpaslan Mehmet Nusret. Economic efficiency of investment in the construction industry of construction machinery and equipment "Economics of Entrepreneurship" №6, part 1, 2015, Moscow, p. 896-899;

4. Ahmet Alpaslan Mehmet Nusret. “Definition of Machinery Manufacturing and Mechanisms in Construction” Finance Economy Strategy ”№5, 2015 Voronezh, p. 45-51;

5. Ahmet Alpaslan Mehmet Nusret. Economic justification of capital investments in construction machines depends on the period of operation of "Audit" № 4, 2015, Baku, p.102-108.

6. Ahmet Alpaslan Mehmet Nusret “Methods of calculating the economic efficiency of newly constructed machines and mechanisms in the field of construction”, ANAS, Institute of Economics Scientific Works №5, 2016, pages 95-103;

7. Ahmet Alpaslan Mehmet Nusret “Determination of economic expediency of service life of construction machines taking into account physical amortization” ANAS, Institute of Economics “Scientific works” №5, 2016, pages 121-127.

8. Ahmet Alpaslan Mehmet Nusret . “Selection of optimal decisions in the field of mechanization in construction with application of mathematical methods” Institute of Economics of ANAS “Scientific works” №6, 2016, pages 153-160.

9.Ahmet Alpaslan Mehmet Nusret . “Economic bases of selection of machines and mechanisms in construction” Monograph Baku 2016, “MSV Publishing” 64 pages

10. Ahmet Alpaslan Mehmet Nusret. Kazan, Russian Federation January 30-31, 2020 at the International Scientific Conference "Innovation in the priority areas of industry" "Scientific and economic justification of the choice of machines and mechanisms in construction." Organizers OOO Gazprom, Transgaz Kazan, OOO Envelope 5 sections.

e-mail: kazan@mail.ru;

11. Ahmet Alpaslan Mehmet Nusret. Article "Solving modern problems in the modern economy and innovation" at the XXXIX International Scientific-Practical Conference on February 5, 2020, Penza, Russian Federation. Organizers:: MCNS “Science and Enlightenment; e-mail: konf@naukaip.ru;

12. Ahmet Alpaslan Mehmet Nusret. Speech on "Determination of economic efficiency of service life of construction machines" at the Republican scientific-practical conference on "Heydar Aliyev and the model of national economic development of Azerbaijan" held by the

Department of "Service Economy and Management" at the Azerbaijan University of Architecture and Construction, Baku, April 24, 2020.

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The dissertation is available in the library of Azerbaijan State Agricultural University.

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