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# A Methodical Approach to Optimization and Application of a Standard Factor of Overhead Costs

**Kulikova Tatyana Andreevna[1, *], Kirikutsa Elena Gennadievna[1], Sinyavin Vladimir Yurievich[2], Bareeva Irkyam Adgamovna[2]**

[1]The Department of Economics and Management, I. M. Sechenov First Moscow State Medical University (Sechenov University), Moscow, Russian Federation

[2]The Department of Management and Economic Security, Penza State University, Penza, Russian Federation

## Email address:

kulikova_t_a@staff.sechenov.ru (Kulikova Tatyana Andreevna), kirikutsa_e_g@staff.sechenov.ru (Kirikutsa Elena Gennadievna), vladimir.siniavin@mail.ru (Sinyavin Vladimir Yurievich), irkysha@mail.ru (Bareeva Irkyam Adgamovna)
[*]Corresponding author

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**Abstract:** Improvement of cost management methods is an urgent problem nowadays due to increasing size and share of overhead costs of enterprises in modern conditions. This paper proposes a methodical approach to overhead cost management to find a compromise between cost optimization and differentiation in terms of developing flexible standards that are connected with strategies and specific operating conditions of economic entities. The implementation of these tasks is based on studying the experience of applying and clarifying the category of overhead cost rationing, based on neoclassical and alternative evolutionary economic theories, the economy of the firm to calculate the overhead rate, and econometric methods for analyzing the cost factors of industrial enterprises. A developmental component of overhead costs was first distinguished in the proposed methodical approach. An algorithm to determine the effectiveness of the overhead cost standard factor in terms of compliance with the objectives of the enterprise has been developed. Practical recommendations for optimizing and using the features of the overhead cost standard factor to increase the efficiency of industrial enterprises have been offered. The use of the proposed methodological approach to standardizing overhead costs as a structural component of cost management systems based on norms will increase the reliability of implementing its following stages, develop well-founded norms that are adequate to the various goals of economic entities, focus attention on overhead costs, improve managerial accounting for economic entities, conduct flexible managerial policies, and productively carry out the managerial process.

**Keywords:** Overhead Costs, Cost Management, Rationing, Standard Factor of Overhead Costs, Goal Setting, Innovation

## 1. Introduction

Modern management conditions are characterized by crisis features, globalization, increasing competition, the need to monitor and quickly respond to changes in the consumer market, the aspiration to widespread introduction of innovation, the improved production base (60.9% of total innovation costs are accounted for purchasing cars and equipment), expansion of automation, informatization and computerization of production, and make industrial enterprises develop continuously. Striving forward can be expressed by innovation activity, development of the social sphere, research and development of new markets, etc. These circumstances are the factors of increasing the amount and share of overhead costs (OC), which percentage is from 600% to 2,000% in the total costs of enterprises today, and it continues to increase.

On the other hand, the listed trends make it necessary to optimize overhead costs and use modern management methods, including improving management accounting, differentiating overhead costs in accordance with production management strategies (by management zones, processes, redistribution, orders, field of activities, etc.). In this connection, let the costs related to achieving development goals be called developmental overhead costs (DC).

The hypothesis of the research is to assume and prove the need and the possibility of improving rationing processes as the basis for managing overhead costs related to achieving targets for development of industrial enterprises.

# 2. Literature Review

### *2.1. Differences in Overhead Cost Management Approaches in Russia and Abroad*

Assessing the features of innovation activities at foreign enterprises, it can be noted that investments in research and development (R&D) increase the efficiency of organizations, but there is very little data about influence of the firm's life cycle stages on the relationship between R&D costs and the efficiency of its activities. Thapalia, Wallace and Kaut were the first who traced this relation [1]. They classified firms into three stages of their life cycle (growth, maturity, and stagnation), and chose variable classifications with four life cycles (dividends, sales growth, capital costs, and the age of the firm). Using observations data for 769 firms over an 11-year period in Australia, it was found that the relationship between productivity and R&D investment is not linear, but is determined by the company's life cycle, being more negative during the stagnation period.

However, it does not matter what stage of the life cycle of the firm the innovations are carried out at, as they require significant costs, most of which are overheads.

The study of foreign experience in managing overhead costs, including the ones at enterprises that are actively engaged in innovative activities, has shown that the differences between Russian and foreign accounting concern the concept definition, and composition of overhead costs (Table 1).

***Table 1.*** *Differences in overhead cost management approaches in Russia and abroad.*

| Parameter of comparison | Domestic accounting | Accounting in Western Europe and the USA |
|---|---|---|
| Estimation of past overhead costs | Costs not related to production technology | Indirect total costs related to the entire output, or costs that neither depend on the production process, or have a decisive influence thereon |
| Estimation of current overhead costs | Costs not directly related to the main production of goods or the provision of services, but necessary for production organization, maintenance and management | All costs of the enterprise except for direct labor and material costs |
| Composition of overhead costs | General production costs (expenses for production maintenance and management);<br>1. running costs (management costs);<br>2. selling costs (expenses related to the promotion of goods from the seller to the buyer) | Production costs (related to the maintenance of the production process);<br>1. administrative costs (expenses for managing the organization as a whole);<br>2. selling expenses |
| Cost accounting system | | |
| Full costing | Production and non-production overhead costs are included in the inventory cost | Non-production overhead costs are period costs |
| Accounting of condensed cost | Direct and production overhead costs (general production costs) are calculated and included in the recurring operations account; general running costs are period costs | Direct and variable overhead costs (variable general production costs) are included in the recurring operations account; fixed costs (general running and fixed general production costs) are period costs |

However, there is some intersection between the composition of overhead costs in Russia and abroad: general production costs are analogous to production overhead costs, and general running costs are analogous to administrative costs [2].

Avelé calls overhead costs as joint costs, arising from joint production manufactured by organizations [3]. The analysis of the current state made it possible to single out two logics of the distribution of the joint cost of related goods: the first is based on market data, and the second one is focused on physical data or material measurements.

### *2.2. Overview of Cost Accounting Systems Used in Global Practice at Russian Enterprises*

Modern foreign scientists pay special attention to cost estimation of production and processes, and, in particular, to the approaches to the allocation of overhead costs. The importance of such studies is undeniable, since the wrong choice of expense estimation method leads to incorrect pricing, which affects the company's profitability.

An attempt was made to determine various prospects for choosing the cost estimation methods, their limitations, cases of application, and the necessary modifications were proposed [4].

To study the factors affecting the inclusion of non-production overhead costs in the cost of production, a survey was conducted by British management accountants in the manufacturing industry. The only significant effect in logistic regression analysis was the share of non-production overhead costs in total expenses or total overhead costs, but the result was unexpected. In particular, the lower the percentage of non-production overhead costs, the more likely it is that operational units will include non-production overhead costs in the cost of production. In addition, there were insignificant consequences for the level of competition, production individualization, the influence of financial reporting requirements on production cost and the size of the operating unit, as measured by annual sales revenue or the number of employees [5].

It was revealed that product costs are constantly used when making decisions to support the profit motive in profit/investment centers, and to cost control in cost centers, and sometimes when making decisions when there are limitations in the costing system, and/or the market plays a significant role in decision making. Operational divisions use production costs as information in decision-making to highlight unprofitable products for special studies in order to identify any necessary additional information, since market information plays an important role in making decisions, and when production costs are not accurate enough to use them directly in making decisions [6].

The cost accounting system adopted in world practice differs significantly from the methods used at domestic enterprises. These differences relate primarily to recording and allocation of overhead costs, as well as the concept of estimation of product costs and period costs.

Even the concept of 'full costing' is often understood differently. In domestic enterprises, production and non-production overhead costs are included in the cost of inventories (that is, they are the product cost). In world practice, the term 'absorption costing', or a cost accounting method is often used in which non-production overhead costs are period costs [2].

According to opinion of foreign scientists, modern costing systems that are being developed to overcome the shortcomings of the traditional method have become popular. For example, the activity-based costing (or, the ABC method) involves grouping of overhead expenses by main types of activities and distributing them among types of production, based on what types of activities are needed to manufacture this production. The ABC method makes it possible to determine the expenses for under-employed capacity to write them off for costs of the period, get more information for managing expenses, and is often used as a strategic management tool, because it analyzes the product expenses or service at various levels of activity, and provides more accurate information about expenses [7].

The ABC method is used by a large number of companies all over the world. Several companies use the ABC method as the main calculation system; however, most companies apply this method selectively in separate departments or for specific types of activities [8].

There is an advanced experience of introducing the ABC method in Indian university for technical education, undergoing some obstacles or problems. However, the results obtained after the implementation of the ABC model show the advantages of introducing an ABC-like modern costing system to facilitate making effective management decisions and adoption of administrative policy [7].

The use of the ABC method at domestic industrial enterprises is very attractive and promising. Skripnik [8] proposes to use the ABC method to substantiate the following decisions: setting a long-term price threshold, business restructuring, and changes in the order book.

An obstacle to the widespread use of the ABC method in Russia is the conservatism of management personnel, high labor intensity and high cost of implementation, the risk of information overload of the enterprise due to obtaining detailed information about expenses [2].

The direct costing method is also widespread abroad, in which the cost of production is formed only from the variable production expenses, and the permanent ones are completely transferred to the sale. This method allows us to simplify rationing, planning, accounting and control of expenses, establish relationships and proportions between expenses and production volumes, evaluate the profitability of certain types of products, and make various operational decisions on enterprise management [8].

The direct costing method is used in 40-90% of large Russian companies, but this application is either purely formal or very limited in character (Application of Direct Costing System in Russia). This is mainly due to the inconsistency of cost accounting with the requirements of Russian legislation according to a condensed item nomenclature, which requires the preparation of accurate calculations.

The standard costing method is widely used in all economically developed countries, which allows one to pre-determine the amount of expected costs for production and sales of goods, to calculate the product unit cost for determining prices, as well as to make an income statement, and minimize accounting procedure. However, the standard costing system is dependent on external conditions, and additional calculations are required for making decisions, since fixed and variable expenses are not differentiated [9].

It should be noted that the standard costing system is not regulated by normative acts in foreign practice; therefore, it does not have a unified standard setting technique and book-keeping.

In recent decades, the combined cost accounting methods have been used by the largest foreign companies with representative offices in Russia (General Satellite, BMW, Ford, etc.). However, they require special development of accounting policies, and are quite time-consuming.

# 3. Methods

### *3.1. Cost-Killing Method*

In the dynamic conditions of the environment in which there are economic entities, it is necessary to regularly monitor and, if necessary, change goals. As a result, industrial enterprises have to revise the policy of managing developmental costs at the stage of their justification by regulating the composition and restructuring overhead costs, and choosing the appropriate cost driver. There is a problem to find a compromise between expense reduction and differentiation, which is supposed to be solved by making adjustments in the interest rate calculation.

The cost-killing method, aimed at reducing costs in the shortest possible time without detriment to the activity of the enterprise and the prospects for its development, should be taken into account here [10]. We see the possibility for searching the reserves to reduce the share of standard OC, and increase the share of developmental OC by eliminating an impersonal mechanism of standardization (that is, detached from information about the targeted use of certain resources), without changing the total amount of OC. In other words, in rationing, it is worth constantly taking into account various factors affecting the size of the OC standards in order to reduce non-productive costs. Thus, there is a need to develop flexible OC standards (tolerant to making adjustments in the course of an enterprise's activity), which will be bound to the goals of economic entities and specific production conditions.

The established standards cause the action of the so-called standard factor of overhead costs, which is understood as a set of established requirements and constraints used in the managerial functions of an organization, involving regulatory support to maintain consistency, ordering and efficiency of activity at industrial enterprises [11]. The OC standards perform a very important role in the management process; therefore, it is necessary to optimize them, which implies the development and implementation of a new methodical approach.

### *3.2. Cost Management System Using the Technique for Developmental Overhead Cost Rationing*

Improving the overhead cost rationing poses the problem of choosing the appropriate concept. Among various economic theories, the neoclassical one is characterized by finding ways to optimize the use of limited resources. However, according to most researchers, it does not pay enough attention to such management tasks as finding markets, improving products and technologies [12]. The founders of the alternative evolutionary theory suggest that a firm is formed under the influence of external and internal factors. Also, the developers emphasize the absence of a single criterion for optimal decision making and changes in the behavior of the firm depending on the situation and goals [11]. To solve the problem of the allocation of limited resources depending on the priority areas of enterprise development, it seems appropriate to combine the postulates of the neoclassical and alternative evolutionary theories, and new elements of the proposed methodical approach to overhead cost rationing (Figure 1, Stages 1-5) to be included in the well-known cost management system based on standards [13] (Figure 1, dashed lines).

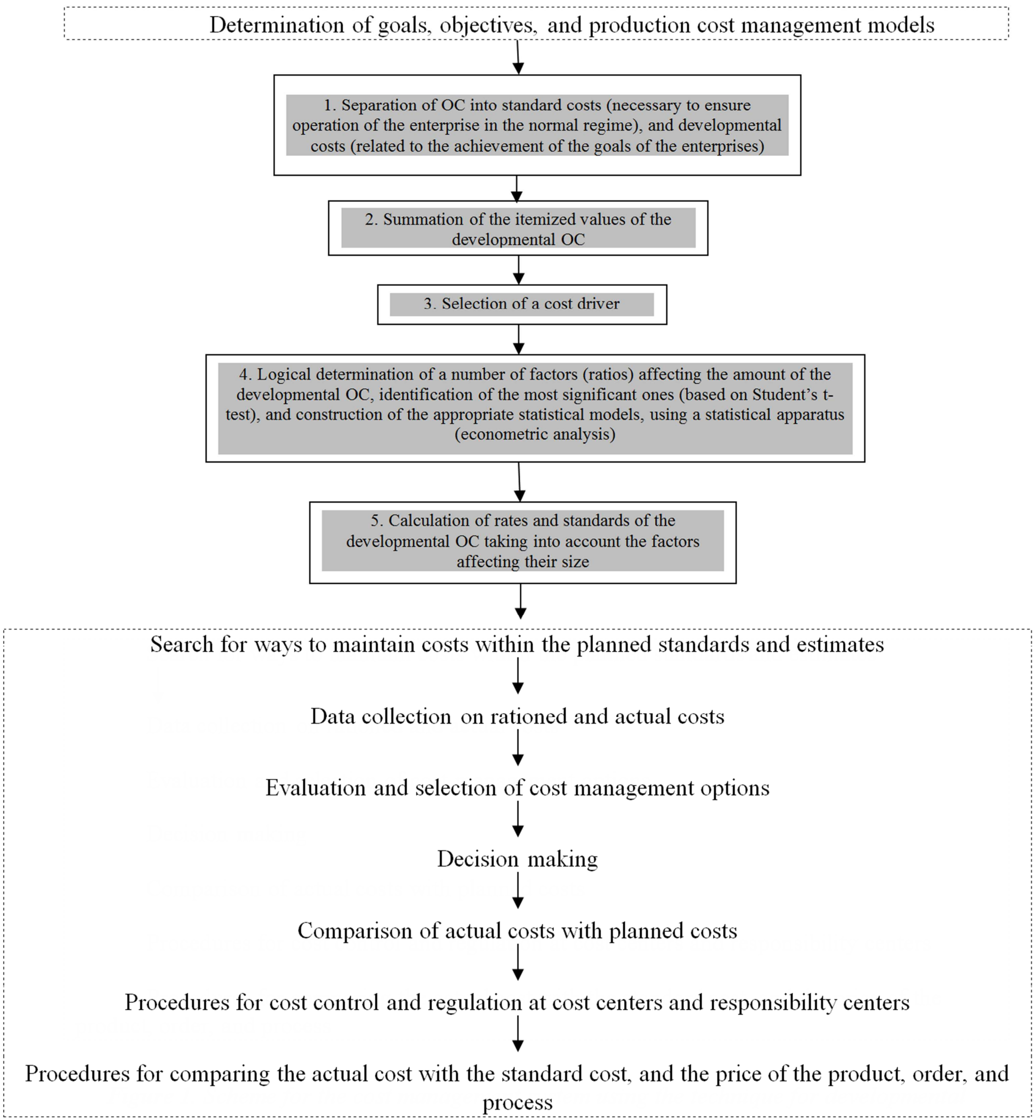


***Figure 1.*** *Scheme for the cost management system using the technique for developmental overhead cost rationing.*

The implementation of the stages of the technique proposed by the authors (Figure 1) has some specific features depending on the ongoing changes. Let us show an example of industrial enterprises implementing an innovative strategy.

Stage 1. Since the development and implementation of innovations is a complex and time-consuming process, the following items of the developmental OC should be supplemented:

1. cost of invention and rationalization for general workshop purpose;
2. maintenance and repair of buildings, structures, and business equipment;
3. depreciation of buildings, structures, and business equipment;
4. deductions for research work;
5. costs for professional orientation and training;
6. expenses of technical propaganda and standardization;
7. production costs for quality (for preventive measures and assessment, for defects and losses, ensuring and controlling the conditions for quality production, i e., predetermining the presence and value of production expenses);
8. costs of information, auditing, and consulting services;
9. costs of tests, research and maintenance of general economic laboratories [14].

Stage 2. Summation of the itemized values of the developmental OC is carried out in a usual way.

Stage 3. In determining a cost driver, it is recommended to give preference to the basic salary, since it still occupies the largest share in the cost structure of enterprises.

Choosing the ratios at Stage 4, characterizing the state of the subject for which the calculation is carried out, one should pay attention to the coefficients of technical renewal, equipment replacement, use of existing equipment, accounting for scientific and technological development, moral production renewal, etc., and include them in nonlinear multiple regression model, which can take the following form:

$$Y=b_0 + b_1 * x_1 + b_2 * x_2^3 + \cdots + b_k * x_n + \varepsilon \quad (1)$$

where Y is the amount of overhead costs of enterprises (thousand rubles);

$x_1, x_2 \dots x_n$ are the coefficients characterizing the state of the subject;

$b_0, b_1, b_2 \dots b_k$ are the regression coefficients;

ε is the stochastic disturbance (takes into account the influence of other factors on the dependent variable Y, which are not independent variables in the model).

Studying the experience of enterprises has shown that the most significant factors are the equipment replacement ratio ($R_r$) and the equipment utilization ratio ($R_u$), which made it possible to include them in the formula for calculating the rate of the developmental OC at the next stage:

$$\text{DC rate} = \frac{\text{DC}}{\text{Score}*\text{Rr}*\text{Ru}} \quad (2)$$

where DC is the planned amount of the developmental OC;

$S_{core}$ is the salary amount of core employees in the period under consideration.

To reflect the effects of wear reliably, it is proposed to take into account different age (state) of the equipment being commissioned or retired. An enterprise may purchase used machines and withdraw not only equipment that has served a significant period, but also fairly new one, due to irreversible damage, for example.

We introduce the wear value, corresponding to each range of equipment service life, which will be understood as a decrease in the degree of serviceability, or a decrease in consumer appeal of certain equipment properties over time as a result of deterioration in equipment specifications, or an increase in the likelihood of such deterioration [14]. The wear will be equal to one, if the equipment has worked from 0 to 5 years since its release at the time of the establishment of standards. If the age of equipment is from 5 to 10 years, then the wear is 1.35 (we take the average age of this category equipment, being 7 years). In other words, the wear value will increase by 0.35 for each subsequent age group of the equipment.

Thus, the formula for calculating the replacement ratio, taking into account the value of the wear rate, will take the following form:

$$R''_r = \frac{\sum_{n=1}^{m} \text{Ncomi}*\text{Wi}}{\sum_{n=1}^{m} \text{Nreti}*\text{Wi}} \quad (3)$$

where m is the number of ranges of the equipment service life;

$N_{reti}$ is the amount of retired equipment of the i-th age interval for the period;

$N_{comi}$ is the amount of commissioned equipment of the i-th age interval for the same period;

$W_i$ is the value of the wear rate of the equipment of the i-th age interval.

# 4. Results

### *4.1. Directions for Applying the Proposed Methodology*

The use of the proposed methodical approach to the rationing of OC as a structural component of the cost-based management system will allow us to develop reasonable standards that are adequate to various goals of business entities; to focus on overhead costs; to improve management accounting of business entities; to pursue a flexible management policy; to implement the management process productively; to increase the reliability of the implementation of the next stages of the basic management system [2].

In addition, you can select another two areas of application of the proposed method, namely:

1. rationing of the developmental overhead costs using SMART goal setting criteria [15];
2. determination of the OC standard factor effectiveness for the adequacy of the organization's specified objectives.

In turn, the implementation of all possible ways requires the creation of appropriate techniques. The method for rationing the developmental OC using SMART goal setting criteria was already described [16], and we will consider the algorithm for determining the effectiveness of the OC standard factor in detail (Figure 2).

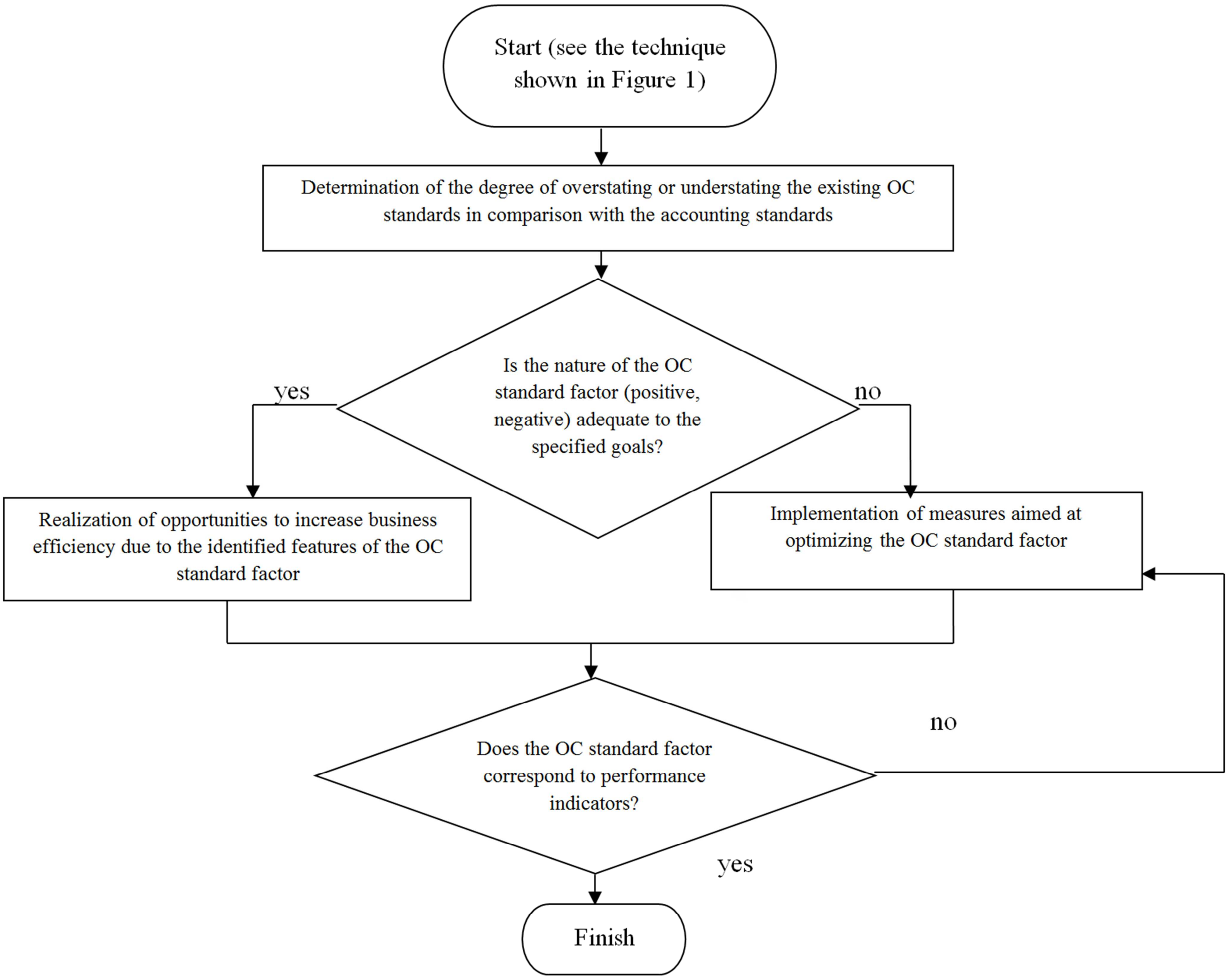


***Figure 2.*** *Algorithm for determining the effectiveness of the OC standard factor for compliance with the objectives of the enterprise.*

The proposed method for calculating the OC rate will allow to identify overstated and understated OC standards, and to correct actions towards their optimization [17], which means achieving the optimal level of the OC standards. Determination of the degree of overstating or understating the existing OC standards is supposed to be carried out by comparing the established standards at a particular enterprise with the OC standards calculated using the proposed technique at Stage 5 (Figure 1).

Solving the problem regarding the overstated and understated OC standards will be based on the OC standard value at the enterprise for the previous period.

Adjusting the overstated OC standards allows increasing profit margins, product profitability and, as a result, sales profitability, reducing profitability threshold, influence force of the operating leverage (IFOL) and entrepreneurial risk, increasing the margin ratio [18].

### 4.2. Practical Recommendations to Optimize the Standard Factor of the Overhead Costs at Industrial Enterprises

The basis for optimizing the standard factor in management of overhead costs is its understanding as the mechanism influencing the management process. As already noted, the OC standard factor can contribute to the achievement of the enterprise goals. Therefore, the OC standard factor will be considered optimal with the growth of target performance indicators, and will be an effective tool for the development of the enterprise.

However, the administration of enterprises may fail to see the expediency of taking advantage of the identified reserve of raising or lowering standards, and would prefer to adjust them, that is, the OC standard factor will have a negative effect from this point of view. Therefore, practical recommendations to optimize the standard factor of the overhead costs at industrial enterprises depending on the nature of the existing standards, identified by the authors, and the goal set by management, are offered (Table 2).

***Table 2.*** *Practical recommendations to optimize the standard factor of the overhead costs at industrial enterprises.*

| Nature of the existing standards | Negative effects of using the OC standard factor | Practical recommendations for optimizing the OC standard factor at industrial enterprises |
|---|---|---|
| Understated | 1. insufficient coverage of production costs;<br>2. reduced product quality;<br>3. tension in workers in the performance of their functions;<br>4. violations in the process and organization of production;<br>5. inhibition of scientific, technical, social and other enterprise development programs;<br>6. staff cuts inadequate to production tasks | 1. elimination of excess production resources;<br>2. increasing product quality control to prevent its decline;<br>3. continuation of the systematic introduction of science and technology, continuous improvement of production organization methods;<br>4. introduction of microelement rationing;<br>5. implementation of systematic control over standards |
| Overstated | 1. overspending resources in production and reducing the desire to save them;<br>2. inefficient waste management;<br>3. increasing losses in production, the emergence of unrecorded resources, theft;<br>4. the lack of measures aimed at improving production technology, the elimination of defects, etc.;<br>5. reduced motivation and effective behavior of staff | 1. management accounting implementation;<br>2. development of methodical support of rationing;<br>3. consolidation of support functions;<br>4. detection and elimination of violations in the technological discipline;<br>5. introduction of new equipment and technology;<br>6. elimination of defects, efficient waste management;<br>7. use of energy and resource saving technologies;<br>8. improvement of organization service and production management;<br>9. improved capacity utilization and fixed assets |

Knowledge and application of the nature of the OC standard factor will allow economists to achieve the goals set by the company's administration.

## 5. Discussion

The effectiveness of the proposed technique was proved by its testing in terms of managing overhead costs at two industrial enterprises in Penza (Russian Federation), namely, CJSC Special Technologies (a small enterprise) and OJSC Penzmash (a large enterprise).

There is an example of calculating the replacement ratio of equipment at CJSC Special Technologies. Table 3 presents data on the number of commissioned and retired equipment, and its service life from 2020 to 2022.

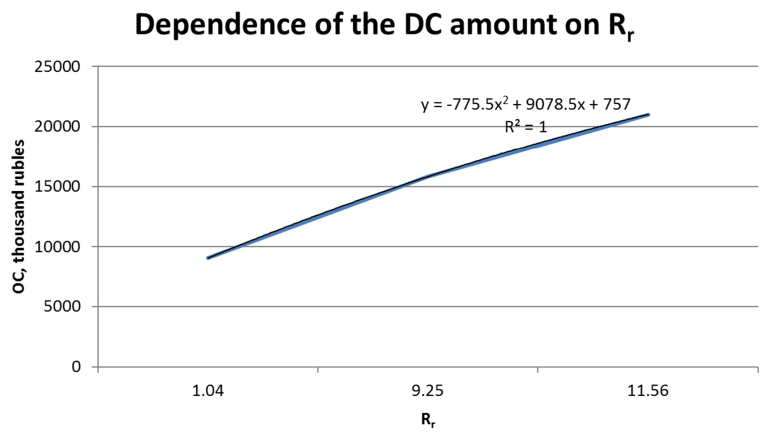


***Figure 3.*** *Dependence of the DC amount on the value of the equipment replacement ratio at CJSC Special Technologies.*

***Table 3.*** *Source data for calculating the equipment replacement ratio at CJSC Special Technologies.*

| Age of equipment | Commissioned equipment | | | Retired equipment | | | Wear |
|---|---|---|---|---|---|---|---|
| | 2020 | 2021 | 2022 | 2020 | 2021 | 2022 | |
| 0-5 | 2 | 3 | 2 | | | | 1 |
| 5-10 | 1 | 3 | 5 | | 1 | | 1.35 |
| 10-15 | 1 | 2 | 4 | | | 1 | 1.7 |
| 15-20 | | 1 | 2 | | | | 2.05 |
| 20-25 | | | | | | | 2.4 |
| 55-60 | | | | 1 | | | 4.85 |

Based on the source data, we calculate the values of the equipment replacement ratio in 2020, 2021, and 2022 using the formula (3):

$$R''_r\,(2020) = \frac{2*1+1*1.35+1*1.7}{1*4.85} = 1.04$$

$$R''_r\,(2021) = \frac{3*1+3*1.35+2*1.7+1*2.05}{1*1.35} = 9.26$$

$$R''_r\,(2022) = \frac{2*1+5*1.35+4*1.7+2*2.05}{1*1.7} = 11.56$$

Figure 3 shows the dependence of the amount of the developmental costs on the value of the equipment replacement ratio.

After processing the data using EXCEL, we obtain the following correlation model: $y = -775.5x^2 + 9078.5x + 757$, where y is the DC amount; x is the equipment replacement ratio. The square of the correlation coefficient (the value of approximation reliability) $R^2 = 1$ shows that the relationship between the studied parameters is established, and the trend line, having the form of a second degree polynomial, is the most accurate one. The ability to approximate data to a graphic curve, rather than just a straight line, allows you to more accurately describe the change in data.

A polynomial trend line is used to describe values that alternately increase and decrease, that is, in displaying the growth of the effective indicator with constant acceleration, which is provided by the influence of certain factors. Polynomial growth curves can be used to approximate (estimate) and predict economic processes in which subsequent development does not depend on the level achieved. Here is a standard second degree polynomial equation:

$$Y = a_0 + a_1 x + a_2 x \quad (4)$$

where $a_1$ is a linear gain;

$a_2$ is the growth acceleration equal to half the acceleration.

The parameters a are constants, the values of which are determined during the construction of the trend line. If $a_2 <$ 0, that is, if acceleration is negative, the trend reflects a slowdown in growth with increasing speed.

The use of polynomial trend lines contributes to the determination of a specific confidence interval (i e., an interval in which the parameters in question are with a given probability).

The degree of a polynomial is determined by the number of extrema (maxima and minima) of the curve. The presented second degree polynomial can describe only one maximum or minimum.

The extremum of the function is at the point that corresponds to the value of the influence of the equipment replacement ratio of 9.25, and the amount of the developmental overheads of RUB 15,812. Initially, the amount of the DC increases to an extremum point under the influence of an increase in the equipment replacement ratio, and it begins to decrease with continued growth in the equipment replacement ratio. There are no minimum points for this trend line, however, limiting ourselves to the fact that the variables x and y cannot take zero and negative values, we arrive at a certain conclusion: there are two points that reflect the minimum possible amount of the DC, which is achieved either with the volume of the retired equipment, being significantly greater than the amount of the commissioned one, or vise versa.

The impact of the equipment utilization ratio on the DC amount is determined by the prevalence of old or new equipment in the manufacture of products. To analyze the effect of the equipment utilization ratio on the DC amount, we will use the same wear rate as used above.

A significant effect of the equipment utilization ratio on the DC amount was revealed only at large industrial enterprises. Table 4 presents data on the amount of available and operating equipment, and its service life at OJSC Penzmash for the period from 2020 to 2022.

***Table 4.*** *Source data for calculating the equipment utilization ratio.*

| **Age of equipment** | **Amount of available equipment** | | | **Amount of operating equipment** | | | **Wear** |
|---|---|---|---|---|---|---|---|
| | **2020** | **2021** | **2022** | **2020** | **2021** | **2022** | |
| 0-5 | 81 | 83 | 88 | 81 | 83 | 88 | 1 |
| 5-10 | 111 | 115 | 118 | 111 | 85 | 101 | 1.35 |
| 10-15 | 32 | 33 | 34 | 32 | 33 | 34 | 1.7 |
| 15-20 | 35 | 35 | 34 | 35 | 32 | 34 | 2.05 |
| 20-25 | 7 | 6 | 6 | 7 | 6 | 6 | 2.4 |
| 25-30 | 5 | 3 | 1 | 5 | 3 | 1 | 2.75 |
| 30-35 | 83 | 83 | 76 | 83 | 78 | 41 | 3.1 |
| 50-55 | 69 | 28 | 8 | 49 | 11 | 5 | 4.5 |
| 55-60 | 122 | 70 | 25 | 52 | 33 | 17 | 4.85 |

Based on the source data, we calculate the values of the equipment utilization ratio taking into account the wear rate in 2020, 2021 and 2022 using the formula:

$$R_u = \frac{\sum_{n=1}^{m} Nopi*Wi}{\sum_{n=1}^{m} Ni*Wi} \quad (5)$$

where m is the number of ranges of the equipment service life;

$N_{opi}$ is the amount of operating equipment of the i-th age interval for the period;

$N_i$ is the amount of available equipment of the i-th age interval for the same period;

$W_i$ is the value of the wear rate of the equipment of the i-th age interval.

$$Ru\ (2020) = \frac{81*1+111*1.35+32*1.7+35*2.05+7*2.4+5*2.75+83*3.1+49*4.5+52*4.85}{81*1+111*1.35+32*1.7+35*2.05+7*2.4+5*2.75+83*3.1+69*4.5+122*4.85} = 0.7$$

$$Ru\ (2021) = \frac{83*1+85*1.35+33*1.7+32*2.05+6*2.4+3*2.75+78*3.1+11*4.5+33*4.85}{83*1+115*1.35+33*1.7+35*2.05+6*2.4+3*2.75+83*3.1+28*4.5+70*4.85} = 0.71$$

$$Ru\ (2022) = \frac{88*1+101*1.35+34*1.7+34*2.05+6*2.4+1*2.75+41*3.1+5*4.5+17*4.85}{88*1+118*1.35+34*1.7+34*2.05+6*2.4+1*2.75+76*3.1+8*4.5+25*4.85} = 0.76$$

The cumulative effect of the equipment replacement ratio, calculated according to formula (2), and the equipment utilization ratio on the DC amount at OJSC Penzmash ($R_r$*$R_u$) is:

2020: 0.01*0.7=0.007

2021: 0.02*0.71=0.014

2022: 0.04*0.76=0.03

Figure 4 shows the cumulative effect of the equipment replacement ratio and the equipment utilization ratio on the DC amount.

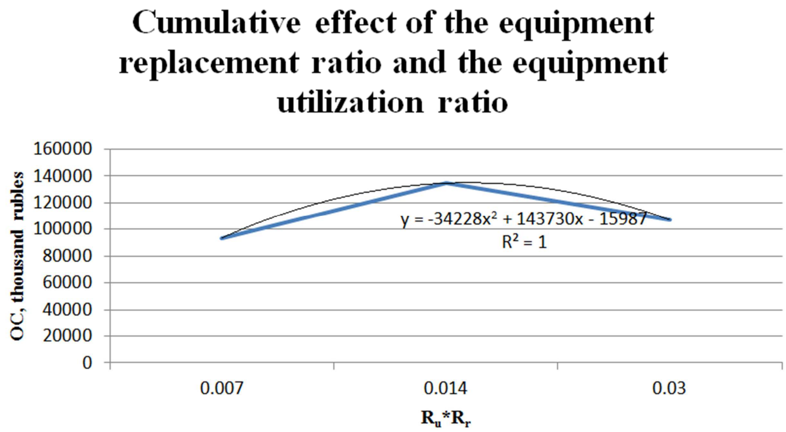


***Figure 4.*** *Dependence of the DC amount on the value of the equipment replacement ratio and the equipment utilization ratio at OJSC Penzmash.*

After data processing using EXCEL, we build a correlation model and determine the approximation reliability $R^2$ = 1, which proves the relationship between the studied parameters. The extremum of the function is at the point that corresponds to the value of the cumulative effect of the ratios of 0.014, and the amount of the overhead costs of RUB 134,560.3. Initially, with an increase in the cumulative effect of the ratios, the developmental costs increase to an extremum point, and then, with a continuing increase in the impact of the factors considered, the DC decrease. There are no minimum points for this trend line; however, limiting ourselves to the fact that the values of variables cannot take zero and negative values, we have arrived at a certain conclusion. Thus, there are two points that reflect the minimum possible amount of the DC, which is achieved either by using the minimum amount of the equipment and the amount of the retired equipment, significantly exceeding the amount of the commissioned one, or by using the maximum amount of the equipment and the amount of the introduced equipment, significantly exceeding the amount of the retired one.

One can determine the DC amount automatically using EXCEL programs, changing the values of the variable x, based on the constructed correlation models of the influence of the equipment replacement ratio and the equipment utilization ratio.

Summing up, we compare the amount of the DC rates with and without consideration of the influence of the considered ratios (Table 5). The calculation of the DC rate for a small industrial enterprise CJSC Special Technologies and a large enterprise OJSC Penmash, is recommended to be carried out according to formulas (6) and (2), respectively, taking into account the influence of the considered ratios:

$$DC_{rate} = \frac{DC}{Score*Rr} \qquad (6)$$

where DC is the planned amount of the developmental OC;

$S_{core}$ is the salary amount of core employees in the period under consideration;

$R_r$ is the equipment replacement ratio.

***Table 5.*** *Comparison of the DC rate amount with and without consideration of the influence of the most significant ratios (according to the calculations of the author).*

| Enterprise | Amount of the DC rate (RUB) without and taking into account the influence of the considered ratios by year | | | | | |
|---|---|---|---|---|---|---|
| | 2020 | | 2021 | | 2022 | |
| | yes | no | yes | no | yes | no |
| CJSC Special Technologies | 10.4 | 10 | 93.7 | 10.13 | 148.9 | 12.88 |
| OJSC Penzmash | 0.008 | 1.19 | 0.02 | 1.68 | 0.04 | 1.3 |

Based on the data in Table 5, we conclude that the rates without considering the ratios turned out to be understated by an average of 88.4% at a small industrial enterprise, and they are overstated by 98.8% at a large industrial enterprise. Thus, if you do not take into account the impact of the presented ratios, then the DC rates will not be reliable, and will not reflect the pace of scientific and technological development and modernization of the enterprise.

Other researchers come to a similar conclusion, pointing out the problem of inflated (Ahmad Abuashour [19]) and underestimation (Diya Abraham et al. [20]) overhead costs at enterprises and suggesting different ways to optimize them.

Rajiv D. Bankera, Gordon Potterb and Roger G. Schroedera revealed that most of the differences in overhead costs in mechanical engineering companies are explained by the indicators of production operations, and not by volume [21].

John C. Lere suggests that when calculating rate of the overhead costs, choose the denominator that most accurately reflects the differences in demand for products on the premises, and represents the batch and product level in addition to unit level cost indicators. At the same time, this researcher sees the need to divide production overhead costs into several cost pools, that will give several rates which reflect differences in the intensity of use of various segments of production capacities [22].

Carsten Homburg analyzes the effects of setting a cost factor corresponding to a higher cost level and points to a heterogeneity driver that is used to apportion all costs due to inflexible overhead costs [23].

John A. Brierley, Christopher J. Cowton and Colin Drury draw attention to the difference in the use of overhead rates depending on the type of production. For example, in the manufacture of individual parts and assemblies, a direct hourly rate is used, and as production increases in a continuous process, units and rates based on production time are used [24].

Kirke Bent, Dennis Caplan describe a cost sharing method, "lattice allocation" uses matrix algebra operations such as those found in standard spreadsheet software [25].

Narcyz Roztocki talks about the need to move away from intuitive costing and proposes the introduction of an integrated costing system based on activity and economic value added in the service sector [26].

Alex Rogozhina, Michael Gallahera, GloriaHelfand, Walter McManus note the difficulty of estimating indirect costs, especially for new products and technologies, and develop the so-called indirect cost multipliers, which are estimated in the range from 1.05 to 1.45 in the short-term and from 1.02 up to 1.26 in the long-term [27].

N. Chiadamrong and P. Wajcharapornjinda solve the logistics cost optimization problem by breaking down overheads according to their cost center and introducing opportunity costs to estimate the neglected costs of non-value-added activities [28].

The authors use the modeling method as the implementation of the developmental overhead rationing methodology also many researchers use this as a method of cost management, including overhead costs.

Li-Chung Chao, Chiang-Pin Kuo developed an improved approach to determining the combined overhead costs and markup rate in the project proposal price, which involves building a regression model based on cost and rate data of collected projects [29].

Agnieszka Leśniak, Michał Juszczyk formed a regression model based on artificial neural networks to predict the overhead index, which allows to combinate with other cost data, to estimate overhead costs [30].

Orlando Duran, Paulo Sérgio Lima Pereira Afonso created an activity-based cost decision model that considers the life cycle of tangible assets (AB-LCC) to better estimate overhead costs across all cost objects of a business unit [31].

The more accurate cost estimation method proposed by Narges Sajadfar, Yongsheng Ma combines linear regression and data mining methods [32].

Leif Pehrsson, Amos H. C. Nga1, David Stockton have developed an incremental cost modeling method integrated with simulation modeling and heuristic search to optimize costs and achieve several conflicting goals [33].

Yanfang Huo, Jie Wang, Bingguang Li, Binshan Lin constract a linear programming model for supply chain systems considering warehousing costs to solve the problem of optimizing total costs [34].

Preetha, K. G. and Unnikrishnan, A. proposed a new method to reduce management overhead by predicting the quality of neighboring nodes in a network using a fuzzy set decision approach [35].

The authors developed the approach of the rationing of overhead costs, based on the allocation of a “developing” component in their structure and considering the target indicators for the development of the enterprise, is like the approach of Frank Stadtherr and Marc Wouters to expanding the scope of traditional target costing [36].

Robert Kee also considers a category of target costs that is consonant with the "developmental costs" proposed in this paper and extends the traditional model of target costs associated with the creation of a new product, which considers market requirements and product development constraints [37].

Shannon W. Anderson argues that coordination and optimization should span the entire value chain and all stakeholders and develops a model that links strategic cost management to strategy development and performance measurement [38]. The methodical approach to the optimization and application of overhead cost standard-factor developed by the authors is also aimed at solving the problem of strategic development of enterprises.

The method presented by the authors of searching for reserves to reduce the amount of overhead costs can be used to solve the problem of reducing costs in supply chains in the industry, set in the work of Annelie I. Pettersson, Anders Segerstedt [39], to optimize the total logistics costs of a trading company, which is necessary according to Dmitriy S. Rybakov [40].

The methodical approach to the optimization and application of overhead cost standard-factor can be integrated into the cost management and decision support model presented by Amir H. Khataie, Akif A. Bulgak, Juan J. Segovia, which allows real-time cost tracking and analysis time [41].

According to John A. Brierley, Christopher J. Cowton and Colin Drury, the use of unified systems and database systems in the British manufacturing industry to determine the cost of production is a significant drawback [42]. The approach presented in the paper to the regulation of overhead costs allows to set their value considering the target indicators of the organization.

## 6. Conclusions

The scientific significance of the study is the development of methodical and practical recommendations for improving the processes of overhead cost rationing at industrial enterprises.

In general, according to the authors, this approach differs from traditional rationing methods in that:

1. It provides the possibility to increase the efficiency of production management by taking into account the influence of various factors on the standards of the developmental OC depending on the goals of enterprises, which will help abandon the impersonal mechanism of standardization.
2. It provides the possibility of flexible regulation of standards, taking into account emerging changes in the operation of the enterprise or given goals.
3. It does not imply a large number of calculations, and it is simple to use.
4. It allows taking into account the nature of the standards, as they are target indicators.

The developed practical recommendations were tested in terms of improving the management efficiency of overhead costs at industrial enterprises, and proved their feasibility and relevance.

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