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Modeling sensitivity indices of industrial enterprise organizational change

Моделювання чутливості показників розвитку промислового підприємства до організаційних змін

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Abstract

Evaluation of sensitivity of commercial enterprises to organizational changes should be made in terms of short-term planning for which it is important to ensure the financial results, as well as in terms of long-term planning, which is important for non-monetary indicators of development effectiveness. To solve this problem, the paper is designed model sensitivity Descriptive indicators of industrial enterprises to organizational changes, reflecting monetary and non-monetary effects of organizational change. The authors determined that the proposed model allows for the analysis of organizational change with regard to their impact on monetary and non-monetary efficiency.

This paper contributes to the theory and practice at the border to ensure a balance between short-term and long-term development of industrial enterprises. Convincingly demonstrated the possibility of using research results in practice.

Аннотація

Оцінювання чутливості розвитку промислового підприємства до організаційних змін має здійснюватися в аспекті короткострокового планування, для якого важливим є забезпечення фінансового результату, а також у аспекті довгострокового планування, для якого важливим є негрошові показники ефективності розвитку. Для вирішення цієї проблеми, у статті розроблено дескриптивну модель чутливості показників розвитку промислового підприємства до організаційних змін, що відображає грошові та не грошові ефекти від організаційних змін. Авторами визначено, що запропонована модель дозволяє здійснити аналіз організаційних змін з врахуванням їх впливу на грошову та негрошову ефективність. Цей документ сприяє теорії та практиці на межі забезпечення балансування між короткостроковим та довгостроковим розвитком промислового підприємства. Переконливо демонструються можливості використання результатів досліджень на практиці.

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Introduction

In recent years, there has been dynamic changes in the industrial environment as a result of further innovations called Industry 4.0 (I.4.0), especially in the field of digital technology and manufacturing (Gajdzik, etc., 2021).

Of all the types of changes that occur in an industrial plant during its development, special attention should be organizational changes. Under the organizational changes we mean a set of changes to any organization providing transformation in managerial processes, organizational structures, methods of management decisions and other administrative elements of modernization or replacement of new (Chichkina, 2011).

Today, most organizations use an approach to enterprise architecture (EA) as a tool to increase power management in the organization (Reyhaneh, etc., 2020).

Managing the development of industrial enterprises through organizational change requires predicting how these changes will affect the performance of development. This prediction should take into account the diversity of situations that cause the need for organizational change and based on a structured method of evaluation of all components of organizational modernization of industrial enterprises. Almost any company faced with changes in their lifetime that require rethinking the business model to be more innovative. These changes are a great opportunity to improve revenues and expenditures, but the associated organizational complexity also has disadvantages through a set of relationships and connections within the firm (Rodríguez, et al., 2020).

For organizational change is inherent in complex, where changes in some processes necessitate corresponding adjustment and modernization of the organizational structure of industrial enterprise. Also, the need for organizational change are often the result of changes in the technological and production in industrial enterprises where new technologies and transition to production of new or improved products, entering new markets, etc. are to be accompanied by organizational changes. In addition to typical organizational change is the emergence of resistance when some part of the labor collective is interested in modernizing

administrative processes and organizational structure. All this makes the complexity of the problem study effects of organizational changes in terms of the final account of their impact on the performance of the industrial enterprise.

This paper presents a model of sensitivity Descriptive indicators of industrial enterprises to organizational changes that could reflect monetary and non-monetary effects of organizational change. Implementation of the proposed model provides a balance between short-term and long-term development of industrial enterprises.

Literature Review

In recent years, published many reports and articles about the need to introduce changes in the production processes in the context of sustainable development. The use of IT systems in production companies creates an opportunity to support the changes implemented in the context of adapting to the concept of sustainable development (Patalas-Maliszewska & Łosyk, 2020).

The main purpose of the study Arsenieva N., et al. (2019) an analysis and practical application of methods for assessing the studied processes for their future development.

The study Linling et al, (2018) analyzed changes in business performance and examined the corporate attributes that correspond to these changes.

The need for the introduction of organizational changes, new technologies and innovative products in the development of this area is beginning to define competitiveness (Tutak, Brodny & Dobrowolska, 2020).

The solution of various components of the problem of assessing the consequences of organizational change in terms of their impact on the development of industrial enterprise was Bezchasny O. (2018 a,b), who proposed to analyze the consequences of organizational change by assessing the effectiveness of organizational communications in industrial development projects. He proposes to evaluate organizational communications in the following areas: product design and development,

production, implementation of orders, support, cooperation, technical control, testing of finished products (Rodríguez, et al., 2020). It is also proposed to carry out optimization of communication depending on the type of information (internal or external) and the entity that is the source of information (government agencies, financial institutions, partners, competitors, owners and managers of businesses, and ordinary workers). However, it should be noted that this study presents evaluation criteria, but does not establish their relationship with the types of organizational change and the situations that necessitated these changes. In addition, the concept of industrial enterprise development and its connection with the quality of organizational communications needs to be clarified, and criteria for optimizing organizational communications should be established.

The study (Chang & Cheng, 2019) developed an integrated multianalytical model of decision analysis to assess the sustainable development of manufacturing enterprises.

Dunska A. (2014) substantiated that the development of adaptive mechanism innovation management of industrial enterprise requires an appropriate organizational form separate to ensure consistency and coherence interests of the innovation process. To build the necessary organizational form of internal organizational practices such as changing the organizational structure, innovative forms of cross-functional relationships, new approaches to planning and control. In addition, Dunska A. (2014) proposes to create specialized units for the development of innovation proposals and program-target groups for the organization of the entire cycle of the innovation process. However, despite the need to use tools of economic and mathematical modeling to predict the development of the enterprise and the consequences of change, the necessary attention is not paid to the development of such tools.

Tarasova A. etc., (2019) offers industrial enterprises adapt to sudden changes in the external economic environment or changes in the trajectory of enterprises. Like others above, this approach lacks formal methods for calculating the quantitative effects of structural changes and justification of indicators of industrial enterprises should be used in the management of industrial enterprise.

Chernyavska I. (2018) investigated the mechanism of action of organizational and management transformation on the development of industrial enterprises and structural model proposed restructuring of industrial enterprises in accordance with the process of structural changes in the adapting to the environment. The directions and types of structural transformations are determined and the factors influencing the market value of an industrial enterprise are selected. Among the organizational changes that affect the value of the enterprise, I. Chernyavska separates transformation in the following areas: manufacturing, inventory management, working capital management, cost management, debt management, and financial management. The main change is the restructuring of equity production, management, liabilities, and assets management. Among the remarks to this approach is the lack of justification as to why its market value is chosen as an indicator of industrial enterprise development, as well as the insufficiently formalized approach to calculating the effects of organizational transformations on enterprise development.

Hroznyi I., et al., (2018) developed a simulation model base diversification of foreign interactions, enabling to evaluate the interplay of key economic indicators and their response to changes in balance. However, without denying the importance of the findings in the study, it should be noted that the proposed principles are not brought to the level of practical evaluation tools.

Shmatko N. (2016) believes that the main problems encountered in the implementation of organizational changes and assessing their effects are the contradictions that exist between the operational and strategic levels of planning structural changes. Therefore, assessing the implications of organizational changes proposed to use the design matrix approach and create a project team to manage the structural and organizational changes.

Despite significant scientific achievement obtained in these studies, it should be noted that the development has not made adequate sensitivity performance evaluation model of industrial enterprise organizational change.

Therefore, the basic idea of the study is to develop a model that will meet the following conditions:

take into account the different types of organizational changes and their impact on typical indicators of industry;

have formalized and structured instruments for quantifying the impact of organizational changes on the development of industrial enterprises; take into account the specifics of the domestic industry and available economic changes taking place in the economic environment.

Methodology

The paper presents the research exercise sensitivity indicators of industrial enterprises to organizational changes in three main phases: situation analysis environment analysis solution space for the implementation of organizational changes and goal-setting. To calculate the efficiency formalized organizational changes and their impact on the development of industrial enterprise proposed to use the model sensitivity Descriptive indicators of industrial enterprises to organizational changes, reflecting cash and non-cash effects of organizational change.

In managing the industry now proposed to separate the three main types of effects of organizational changes:

negative, leading to degradation of the organizational system; neutral, supporting the activities of industrial enterprises in a state of homeostasis;

positive, ensuring the development of an industrial enterprise.

Moreover, the same organizational change can have a combination of different consequences for different components of the organizational system of an industrial enterprise. Also, organizational change can be both desirable and planned within the development and forced undertaken to minimize negative consequences.

Last often lead to the degradation of the system for example, such changes include reduction units responsible for forecasting and development of industrial enterprises by reducing costs under the economic crisis condition.

Analysis of how organizational changes in the industrial enterprise affect its development is proposed to be carried out according to the scheme is shown in Figure 1.
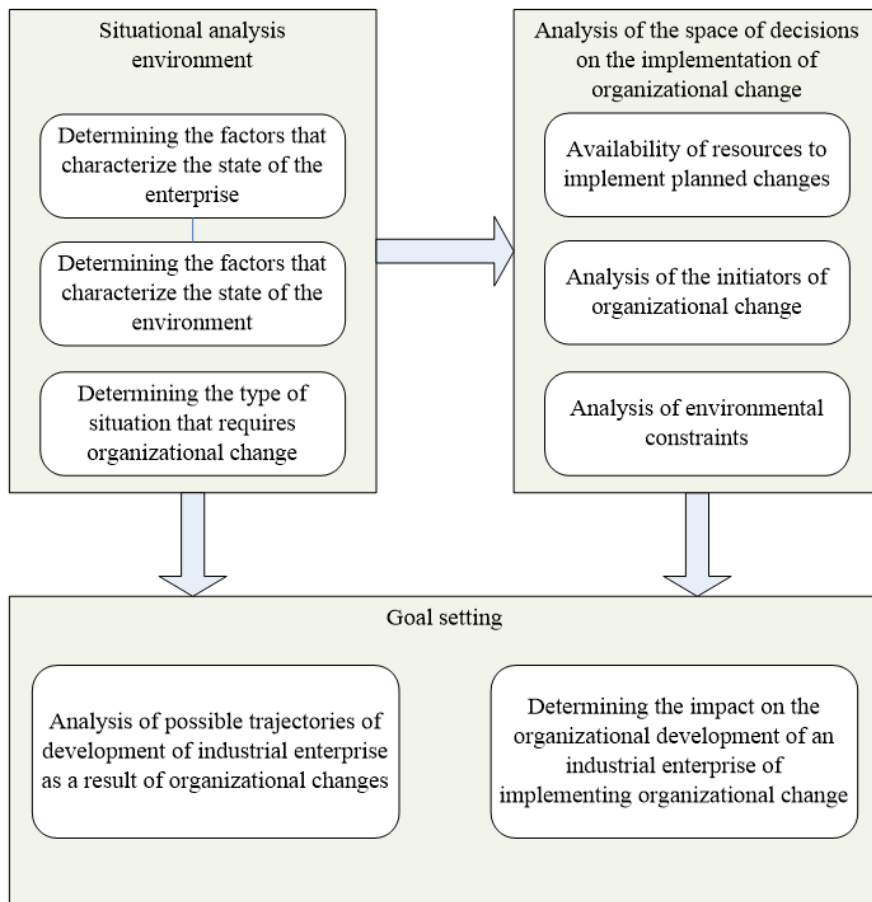
Figure 1. Research of sensitivity of indicators of development of the industrial enterprise to organizational changes. Source: developed by the authors

First of all, the study of the sensitivity performance of the industrial enterprise to the organizational changes necessary to carry out situational analysis of the environment in which operates an industrial enterprise.

Measuring the sustainability of industrial activity in manufacturing firms remains a major challenge for both policymakers and industry decision-makers, as many firms, especially small and medium-sized enterprises, try to interact properly with them (Trianni, etc., 2019).

The results of principal components analysis and cluster analysis show different clusters of firm behavior, depending on external stimuli and internal obstacles (Franco, 2021). It is necessary to determine exactly what factors caused the need for change, because it depends in which direction to development of industrial enterprises. Such factors may be changes in the external environment or internal processes of the industrial enterprise. Set these factors constitute an appropriate description of the situation that characterizes the state of the company and the type of situation that characterizes the state of the environment. Based on them, the type of situation is determined, which requires organizational changes.

Among the factors that characterize the state of the environment of an industrial enterprise, and which give rise to the need for organizational change, can be distinguish the following:

occurrence of extensive growth opportunities for industrial enterprises to capture new markets or increase market share;
lack of competitiveness of industrial enterprise that needs improvement in the area of organization management;
changes in economic, tax, economic and other types of legislation;
the development of the general economic crisis, which requires changes in the system of industrial enterprises for the content or use of targets for management development in new directions.

Typical factors that characterize the state of the company and require analysis in terms of organizational aspects are:

Limitations of this environmental factors that prevent industrial enterprise to desired organizational changes. For example, the cost required to attract external funding, availability of appropriate experts in the labor market, legal restrictions and more.

constant non-fulfillment of planned indicators, which is not caused by the influences of negative external factors;
the change Development Targets given to owners and senior managers of the enterprise, for example, shift from maximizing profits to maximize the value of industrial enterprises;
the transition of the enterprise to another stage of the life cycle, which requires appropriate changes in its structure and management methods.

Thus, as a result of factors external or internal environment formed situation that requires organizational change. These situations are:

lack of resources for the maintenance of the current organizational structure, leading to negative changes due to the reduction and minimization of costs;
the need to implement business processes that are not able to master the current organizational structure, resulting in the need to carry out reorganization or increase;
the need to introduce other types of changes, which result is organizational change, which can lead to a simplification of the organizational structure and its expansion or reorganization.

Together with the situational analysis of the environment of the industrial enterprise at research of organizational changes it is necessary to carry out the analysis of space of decisions concerning realization of organizational changes.This is determined by: the availability of resources to implement the planned changes; initiators of organizational change; environmental restrictions.

For organizational change main resource is human resources that a sufficient number of qualified professionals who can perform improved or reorganized business processes. An alternative to human resources can be financial, ie attracting qualified professionals outside, but it is not always possible due to lack of necessary specialists in the labor market.

Initiated organizational changes can be both senior management at the enterprise development strategy of industrial enterprise, her middle management, who first noticed the discrepancy organizational capacity of industrial enterprise environmental requirements.

Situation analysis and environmental analysis solution space to implement organizational changes give reason for Targeting industrial enterprise in terms of implementation of organizational changes. The following stages are

implemented: determine the impact on the organizational development of industrial enterprise implementation of organizational changes; analysis of the possible trajectories of organizational structure of industrial enterprise as a result of the changes.

The objectives of the organizational development of industrial enterprise by implementing organizational changes determined depending on what organizational changes are set to potential industrial enterprises within the constraints of the environment and the availability of resources to implement these changes.

Goals are set by interviewing the initiators of change, which should justify their consequences. It is necessary to assess what is the expected effect of the organizational changes in characteristics such global efficiency of industrial enterprises as costs, revenues, market value. The analysis is proposed to be carried out in the following areas: changes in the organizational structure, changes in business processes, changes in staff qualifications. For

each of these areas initiators changes required clarification and specification of what changes are expected for each of these areas. As a result, every change initiator must complete Table 1 of estimates how changes affect the key indicators of industrial enterprises (KPI, Key Performance Indicators).

Companies have to deal with different KPI, which helps to focus on the parameters of a particular company and are powerful tools in the management (Kaganski, etc., 2017).

Industry and academia require the development of a common and managed set KPI (Neri, etc., 2021).

For industrial enterprises of Ukraine, carrying out organizational changes are most relevant key performance indicators such as production equipment load, percentage of the plan, index of customer satisfaction, the coverage ratio of strategic competencies. However, this list may be edited depending on the characteristics of each industrial enterprise.

Table 1.
Template for determining the relationship between the effectiveness of organizational development of industrial enterprises and organizational change according to the initiators of change.

Direction of organizational change	Concretization of the content of organizational changes	KPIs that depend on organizational change			
		Loading of production equipment	Percentage of implementation of plans	Customer satisfaction index	The coverage ratio of strategic competencies
Changes in the organizational structure					
Changes in business processes					
Changes in staff qualifications					

Source: developed by the authors

Possible trajectory organizational development of industrial enterprise as a result of organizational changes depend on the following factors:

resource costs required for organizational change:

connection of key indicators of industrial enterprise activity with development indicators; confidence interval, which depends on the distance of the forecasting period.

Determining the impact on the organizational development of industrial enterprises

implementing organizational change provides an opportunity to assess what organizational changes associated with the development of enterprises, and analysis of possible trajectories organizational efficiency of industrial enterprises from changes provide grounds for evaluating the strength of the connection and deviations. Thus, the stage is set sensitivity parameters Targeting organizational development of industrial enterprise organizational change by calculating the appropriate economic and mathematical models.

Model sensitivity indices of industrial enterprise organizational change is descriptive that can be used in management decisions based on simulation. First of all, it is necessary to synthesize the index of industrial enterprise that is representative in terms of display quality organizational development. This index should reflect both quantitative efficiency of organizational development in the form of profit growth as a result of organizational changes and increase the efficiency of quality that can be measured through the monetary effects, but affects the overall competitiveness of industrial enterprises in today's dynamic environment.

The effectiveness of organizational change in an industrial plant in monetary terms proposed to evaluate the ratio of increase in income from organizational changes and costs of these changes. The effectiveness of organizational change at the industrial enterprise in non-monetary terms offered viewed as integral index of key indicators of industrial enterprises in the field of organizational support.

The overall efficiency of organizational development of industrial enterprises in monetary terms is calculated as:

$$E^M(t) = \frac{\sum_n \Delta D_n(t)}{\sum_n R_n(t)},$$

where $E^M(t)$ – evaluating the effectiveness of the organizational development of industrial enterprises in monetary terms in the t-th month;

$\Delta D_n(t)$ – increase in income of an industrial enterprise in the t-th month due to the implementation of the n-th organizational change;

$R_n(t)$ – costs of industrial enterprise in the t-th month because of the n-th organizational changes.

In turn, the effectiveness of organizational change on industrial enterprise in non-monetary terms is estimated as the arithmetic mean of all changes, and each change is evaluated by several key indicators as a geometric mean:

$$E^O(t) = \frac{\sum_n \left(\sqrt[z]{\prod_z \partial K_{zn}(t)} \right)}{N},$$

where $E^O(t)$ – evaluation of the effectiveness of industrial enterprise organizational changes in non-monetary terms in the t-th month;

$\partial K_{zn}(t)$ – z-year growth of key performance indicators of industrial enterprises in the organizational field in the t-th month because of the n-th organizational changes;

N – number of organizational changes planned in the strategy.

The calculation of the efficiency of each organizational change as geometric mean grounded so that it better meets the objective analysis of normalized values and analysis of dynamic phenomena (Senthil, 1997) Thus the key indicators of industrial enterprises, which can be from 0 to 100, normalized using a power function to provide greater importance growth rate at its low values (which are critical for industry) and reduce the importance of approaching the maximum possible value.

$$\partial K_z(t) = \left. 1 + \frac{\frac{1}{k^{Pz(t)}} - 1}{\frac{1}{k^{100}} - 1} \middle/ 1 + \frac{\frac{1}{k^{Pz(t-1)}} - 1}{\frac{1}{k^{100}} - 1} \right.,$$

where $\partial K_z(t)$ – increase normalized value z-th key performance indicators of industrial enterprises in the organizational field in the t-th month;

$K_z(t)$ – normalized value z-th key performance indicators of industrial enterprises in the organizational field in the t-th month;

k – saturation factor that reflects the importance of changing the key indicator of industrial enterprises in the field of organizational depending on approaching the maximum possible value;

P_z (t) – the z-th key performance indicators of industrial enterprises in the organizational field in the t-th month.

Thus, while reducing the growth rate of the importance of efficiency in the process of approaching the maximum possible value, respectively, decreases the growth rate of this index as shown in Figure 2.
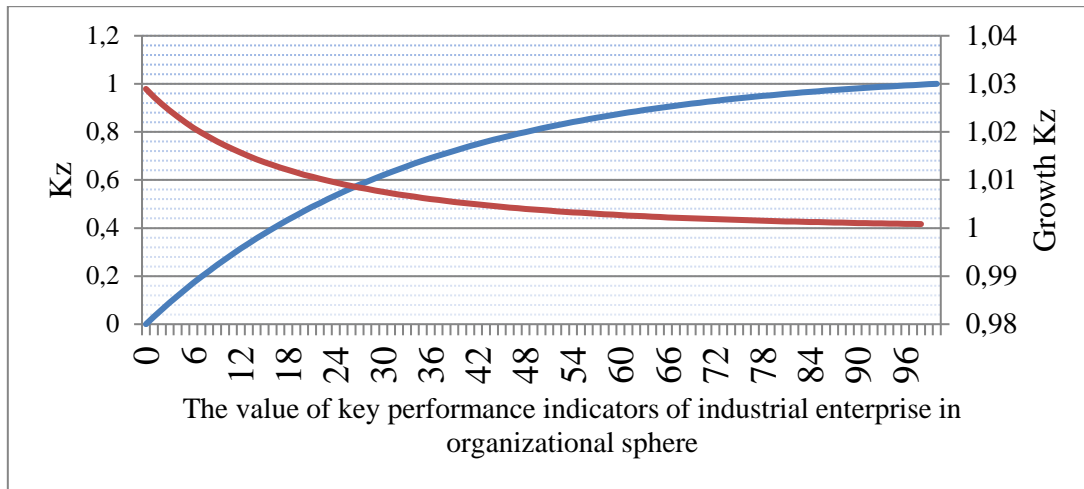
Figure 2. The valuation of key performance indicators of industrial enterprises in organizational sphere at k=1,03
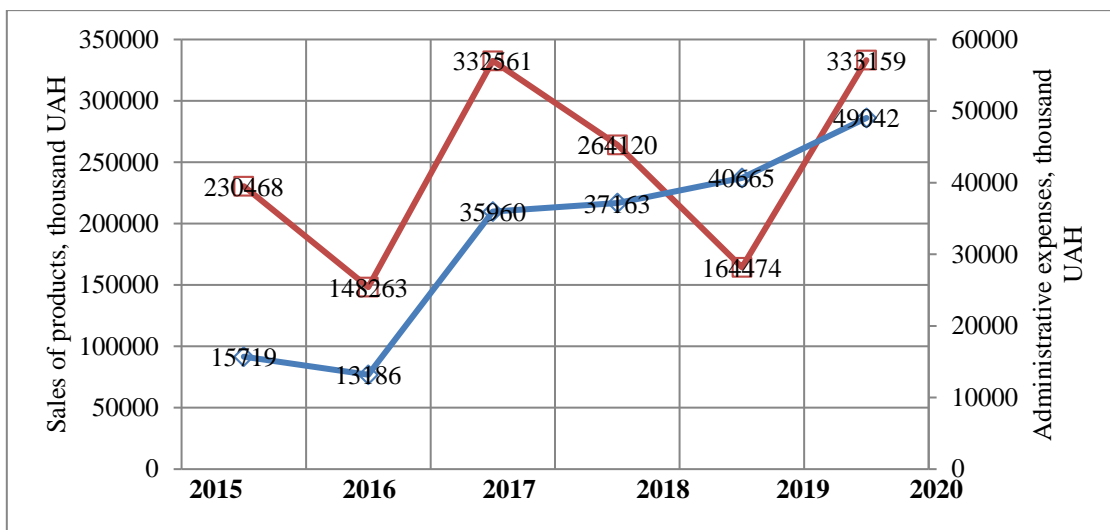Source: developed by the authors

Significantly improve performance indicator industrial enterprise organizational changes in non-monetary terms could lead to deterioration of efficiency in monetary terms, since the implementation of all planned changes will increase costs and do not always lead to a proportional increase in revenues. At the same time, too much attention is given to that performance indicators in monetary terms can lead to short-term increase revenues or reduce costs, but also the degradation organizational areas of the company. For example, the reduction of non-production departments can reduce costs, but to leave the company without the necessary planning and forecasting system. The objective of organizational development management in industrial enterprises is to provide such a path of development, in which both performance indicator are in balance.

Thus, the model sensitivity indices of industrial enterprise organizational change provides an opportunity to analyze organizational changes with regard to their impact on the effectiveness of monetary and non-monetary, thus ensuring a balance between short-term and long-term development of industrial enterprises.

Results and Discussion

Approbation proposed model implemented at JSC Starokramatorsk Machine-Building Plant. This company has organizational problems in the area, one manifestation of which is the continuous increase in administrative costs that do not have the desired effect as improve profitability, increase in sales etc. Thus, from 2015 to 2020, the administrative costs of JSC Starokramatorsk Machine-Building Plant increased threefold, from 15,719 thousand UAH up to 49042 thousand UAH is shown in Figure 3.

Figure 3. Dynamics of revenues from sales and administrative costs of JSC Starokramatorsk Machine-Building Plant.
Source: developed by the authors

At the same time labor costs from 2015 to 2020 increased by only 51%, operating expenses decreased by 18%, revenues from sales of products (goods and services) increased by 46%.

The net financial result of JSC Starokramatorsk engineering plant did not meet the increased costs, and in the last two years became negative as shown in Figure 4.
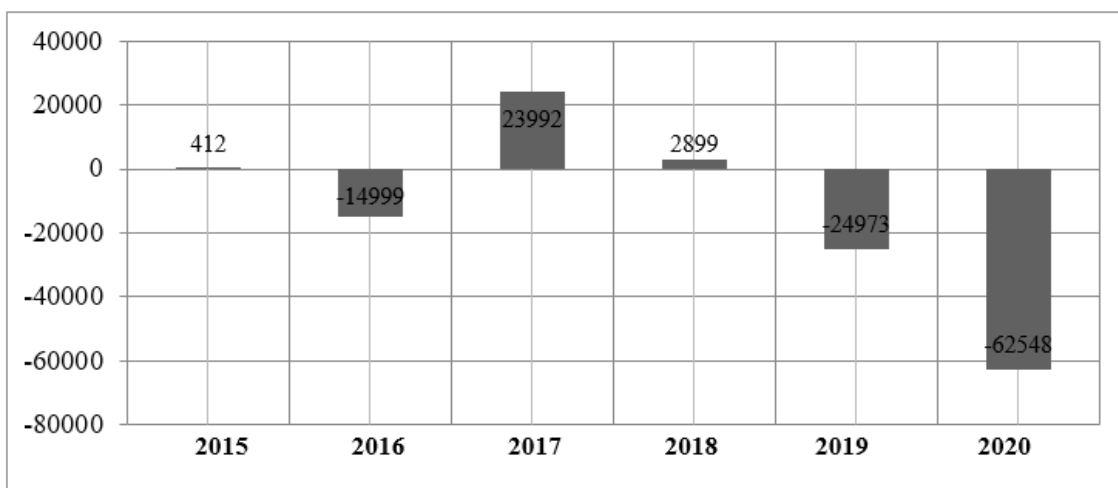
Figure 4. Dynamics of net financial result of JSC Starokramatorsk Machine-Building Plant, thouthand UAH
Source: developed by the authors

Consequently, a significant increase in available administrative costs, which was not accompanied by effects such as improving financial results, on the contrary, the effectiveness of JSC Starokramatorsk Machine-Building Plant deteriorated and the last two years the company is unprofitable. This is due mainly targeting businesses in the internal market, non-compliance of the organizational structure of the task, lack of qualified personnel, too many administrative staff. To overcome the problems in the organizational sphere of JSC Starokramatorsk Machine-Building Plant should make reducing the administrative personnel by consolidation units, training of marketing personnel to enter foreign markets, staff development planning and finance department, professional production staff to increase productivity, improve business process planning and forecasting.

Expected effects of the implementation of organizational changes at JSC Starokramatorsk Machine-Building Plant as key indicators of growth and income businesses are shown in

Table 2. Estimates given in percentage points, that calculation is a refinement of the basic prediction of the enterprise without change.

Table 2.
Expected effects of the implementation of organizational changes at the JSC Starokramatorsk Machine-Building Plant.

Organizational changes	Expected effects				
	Increase revenue or reduce costs	Increasing the load factor of production	Increasing the percentage of implementation plans	Increase customer satisfaction index	Increased coverage ratio strategic competencies
Reduction of management staff by consolidation of divisions	+3,5 p.p.	---	---	---	---
Advanced training marketing personnel to enter foreign markets	+10 p.p.	+6 p.p.	---	+8 p.p.	+4 p.p.
Advanced training of the staff of the planning and finance department	---	+3 p.p.	+6 p.p.	---	+2 p.p.
Advanced training production personnel to increase productivity	---	+3 p.p.	+2 p.p.	+4 p.p.	---
Improving business planning and forecasting	+1,5 p.p.	+2 p.p.	+2,5 p.p.	---	---

Source: developed by the authors

Thus, the estimation of sensitivity performance of the industrial enterprise organizational change provide grounds for development strategy of overall development of JSC Starokramatorsk Machine-Building Plant.

Conclusions

The study authors found that organizational change is one of the most important components of change industrial enterprises, as domestic industrial organizational inertia inherent in the management due to inheritance of institutions since the Soviet planning system. For organizational change is inherent in complex, where changes in some processes necessitate corresponding adjustment and modernization of the organizational structure of industrial enterprise. Also, the need for organizational change are often the result of changes in the technological and production in industrial enterprises where new technologies and transition to production of new or improved products, entering new markets, etc. are to be accompanied by organizational changes.

The authors propose to study the sensitivity of industrial development indicators to organizational change in three main stages: situational analysis of the environment, analysis of the space of decisions on the implementation of organizational change and goal setting. To calculate the efficiency formalized organizational changes and their impact on the development of industrial enterprises Descriptive models developed sensitivity indices of industrial enterprise organizational change, reflecting monetary and non- monetary effects of organizational change.

The presented model in this study can be used in management decisions based on simulation. The authors have shown that it is necessary to synthesize the index of industrial enterprise that is representative in terms of display quality organizational development. This index should reflect both quantitative efficiency of organizational development in the form of profit growth as a result of organizational changes and increase the efficiency of quality that can be measured through the monetary effects, but

affects the overall competitiveness of industrial enterprises in today's dynamic environment.

Further development of indicators of sensitivity studies of industrial enterprise organizational change will be to clarify and expand the list of effects of organizational changes on the basis of their features.

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