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Article

INFORMATION PROCESSES IN MODERN ENTERPRISE MANAGEMENT IN THE SYSTEM OF VIRTUAL ECONOMY

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Abstract. The developed methodological recommendations regarding the formation of a range of scenarios for the development of industrial enterprise activity, taking into account the indicators of enterprise management information processes based on the construction of management scenarios allow to explore the activity of the enterprise comprehensively. The proposed and implemented recommendations during the evaluation of information management processes of the enterprise, combine the scenario approach and the method of correlation-regression analysis, as well as they allow to determine the impact of integrated indicators of labor, manufacturing and financial sphere on the indicator of ensuring the management effectiveness regarding information processes using different scenarios: pessimistic, neutral, optimistic. An important step in the evaluation process of the enterprise's activity is to determine the dominant in different development scenarios factors which influence the effectiveness of the information process of industrial enterprise management. Thus, during the pessimistic and neutral scenario, enterprise development is possible by increasing the usage efficiency of production means, such as labor and production funds. During the transformation, process from a pessimistic to a neutral scenario, the role of material incentives increases, in particular, the size of wages. In terms of the optimistic development scenario of enterprise, the priority of the solvency factor is increasing. Identified dominant factors make it possible to influence the state of the enterprise and reduce its sensitivity to changes. The developed methodical approach to the evaluation of the enterprise's information management process effectiveness is aimed at determining the critical levels of indicators, compliance with these indicators will improve the efficiency of the information management process of an industrial enterprise in case of gradual implementation of its stages. Implementation of the proposed methodological approach based on determination of indicators' limiting values allows to make the transition of the enterprise from a pessimistic development scenario to a neutral one, as well as from a neutral one to an optimistic, which in turn provides an opportunity to determine the target development parameters of the enterprise depending on the current state of its activity.

Keywords: information processes, strategic management, development scenario, principal component method, economy informatization.

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Introduction

At the stage of global economic relations development, effective transformations on the enterprise are possible, mainly through information processes, which explains the usage of information in management as the main factor of providing competitive advantages for the state and for each enterprise. Support of the information management processes requires new approaches and methods for analyzing information, as well as optimizing the directions of external and internal information flows. The information process becomes a qualitatively new production resource, which contributes to the manufacturing growth of information products and knowledge, rapid economic development at relatively low growth rates of material production. Nowadays, evaluation issue of information processes in management has become the subject of increased attention, reflecting the awareness of scientists that the modern industrial enterprise has significant differences, regarding the operation goals and the methods for achieving them, as well as requires fundamentally different management methods. In particular, all management functions require decisions regarding what requires effective communication and information exchange, implementation of certain information processes at all stages of the management process (goal setting, planning, regulation). Thus, management is a type of intellectual work that requires careful observation of facts, recording and storage of data, their control and analysis, selection and decision making. Substantiation of theoretical and methodological aspects of information process evaluation, as well as development of practical recommendations for their usage in the management of industrial enterprises in the informatization context of the economy – are the main purposes of the work.

Literature review

The current economic situation is characterized by the dynamism of the external and internal environment of enterprises, which are inherent in both the world and national economies (Jallow A. K., Demian P., Anumba C. J. & Baldwin A. N., 2017).

These changes create certain opportunities, but also serious threats to the stable functioning of enterprises, which in turn determines the need for quality and clear management in order to ensure their effective operation and development (Callahan C. & Soileau J., 2017).

It is well known that an enterprise, as a system, is not static in the long term and is constantly influenced by many factors, which necessitates its constant transformation, adaptation to a large amount of rapidly changing information (Centobelli P., Cerchione R., & Esposito E., 2018).

Qualitative management, in these circumstances, requires sound strategic and tactical decisions to be made during the development process of the enterprise; also, it requires clear and effective management tools (Hong J., Zhang Y., & Ding M., 2018).

Global development trends in society lead to the need to expand the usage of information, as well as information processes in management (Laumer S., Maier C., & Weitzel T., 2017).

The accelerated development pace of the information sector of the economy, where information is an important resource both at the level of society and at the level of the individual enterprise - is basic for modern society (Cooper R., 2017).

Thus, information from the additional factor of social manufacturing is transformed into a factor that significantly influences the economy, defense capability and politics (Florio C., & Leoni G., 2017).

Moreover, it should be noted that it is becoming almost a direct factor of economic growth, attracting a large part of material resources, and therefore it is an information potential (Zhuo Z., & Zhang S., 2019) or information resource of the socio-economic system, as well as a source of positive results at the level of society and enterprise (Olson D. L., & Wu D. D., 2017).

Thus, it is believed that modern management should be based on the ordering of information and information processes, which in turn will provide access to actual data and necessary resources in the management decision-making process (Berry-Stölzle T. R. & Xu J., 2018).

The efficiency of the enterprise activity is mainly determined by the development and effectiveness of the information infrastructure and the qualitative information usage (Li X., 2018).

It is well known that any process in an enterprise, from the risks it carries, to the maximum profit - is a two-way phenomenon (Appelbaum D., Kogan A., Vasarhelyi M. & Yan Z., 2017). Therefore, it is necessary to find certain possibilities of information and to change the mechanism of its usage in order to ensure a balance in which all processes in the enterprise will coexist harmoniously.

Methods

Fundamental provisions of economic theory and management are the theoretical and methodological basis of work.

In order to achieve this goal, the following general scientific and specific research methods were used: abstract-logical method, systematic approach, methods of analysis and synthesis - in order to clarify the concept of management information process, to define its characteristics and system of evaluation indicators; graphic - to visualize the results. The principal component method was used in order to determine factors that ensure the information management formation process on the industrial enterprise, taking into account all the benefits of mathematical modeling. Unlike simple methods of factor analysis, it allows to identify a sufficient number of characteristic factors of the phenomenon under study.

Compared to the group method, the advantage of using the principal component method is that it does not require pre-selection of elementary features, which in turn allows to simplify the analysis. The method of principal components differs from the method of principal factors by a much simpler logical construction; moreover, the general idea and target settings of factor analysis methods become clear thanks to this method.

The principal component method determines the k component of those factors that explain all the variance and correlation of the initial k variables; the components are formed according to the decay rule of the particle, which is explained by them, the total variance of the original variables, which allows to be limited to the first few components.

The first principal component F_1 defines the direction of the original features in the space, in which the set of objects (points) has the greatest dispersion.

The second principal component F_2 is constructed provided that its direction is orthogonal to the direction of F_1 , also it should explain most of the residual variance, etc. to the k main component F_k . Such transformation allows the information bulk to be narrowed by rejecting coordinates corresponding to the directions with minimal dispersion. Thus, the usage of the principal component method allows construct an integrated method of assessing the scenario of industrial enterprise management, which will be free from subjective evaluation and will be based on a significant number of factors.

Researches of scientists on problems of enterprise's strategic management, periodicals, results of expert surveys, resources of the Internet have become the information base of the research.

Results and Discussion

During the process of managing an industrial enterprise on the basis of evaluating the effectiveness of the information process, it is necessary to take into account the peculiarities of information, especially its ability to be a means of displaying processes, events, phenomena, as well as ability its multiple usage.

Depending on the stages of the management process, the role and importance of information varies. In some cases, its amount, structure, availability of sources are important; in others, its movement or possibilities and terms of accumulation and processing.

Thus, in the process of goals setting, the amount of information, its scientific and technical novelty, completeness are important, but in the process of situation assessment - the structure of the presentation, which determines the possibility of a systematic approach to evaluation, and during the decision making process - the ability to process this information, its timeliness and

completeness. Moreover, reliable and comprehensive information is the basis not only for operational and tactical, but also for strategic planning on business entities.

The economic development of the enterprise involves purposeful, quantitative and qualitative changes, which are influenced by certain regularities and lead to structural transformations, ensuring the effective functioning of the economic entity in the long term. Sustainable development, constant analysis of the factors influencing the information environment of an industrial enterprise will provide an opportunity to increase the adaptability of the enterprise to changing environmental conditions and to ensure its effectiveness in adverse conditions, as well as to increase its competitiveness.

In order to organize an effective information management process of an industrial enterprise, first and foremost, it is necessary to determine the priority management areas. For this purpose, factor analysis was used in the research process, aimed at identifying the factors that are crucial for each of the enterprise activity development scenarios. Identification of such factors will allow to concentrate on improvement of the priority problem areas of the enterprise's activity and also to determine the optimal meanings of information support indicators, adherence of which will help to increase the efficiency of entire management on the enterprise.

Considering the main disadvantages of the existing integrated methods for evaluating the efficiency of forming the information management process of an enterprise, in particular: the usage of the peer review method and the identification of insufficient factors; usage of inaccessible data. During this research the following requirements to the method of determining the priorities of enterprise management, based on the formation of management information process were identified:

- leveling of subjective evaluation during the calculation process of the final indicator or any component;

- taking into account as many factors as possible that influence the scenarios of the enterprise activity development;

- the usage of statistics data, which determine the factors of ensuring the efficiency of the information management process on the industrial enterprise, which are reflected in accounting and financial statements. This approach makes enterprise data accessible;

- validity of the approach from a mathematical point of view.

Taking into account everything mentioned the above, we can summarize that the factor analysis of the efficiency of the information process of managing an industrial enterprise in accordance with the scenarios of economic development of its activity was carried out during the research.

The study used the following indicators, which were selected in the previous stages of the study: workforce, production resources and finance to analyze the basic indicators of factor analysis. The data is official, reliable and available for usage information contained in the forms of enterprise's accounting and statistical reporting. Normalized values should be used (the distribution by the value of the maximum meaning of a factor) when constructing a system of output data, because it is measured in incomparable quantities.

Factor is a latent indicator built on principles to explain the correlation between a set of available indicators. Each variable of the factor analysis can be expressed by a linear combination of latent factors using the following equation 1:

$$X_i = a_{i1} \times F_1 + a_{i2} \times F_2 + \dots + a_{im} \times F_m - U_i \quad (1)$$

where X_i – indicator; i – number of indicators; a_{im} – factor load and for each m -component; F_i – major component; U_i – free member in the equation.

Latent factors are also expressed by linear combinations of the studied indicators:

$$F_i = b_{i1} \times x_1 + b_{i2} \times x_2 + \dots + b_{ik} \times x_k \quad (2)$$

where b_i – coefficient meaning for the factor x_i .

Factor analysis was conducted separately for each of the development scenarios of the enterprise activity in order to determine the indicators that have led to the transition from one scenario to another.

The principal component method was implemented using Statistica 13.2 software. It is advisable to rotate the factors in order to improve the results of the factors and to obtain a solution that will have the further economic interpretation.

The rotation of the coordinate axes was performed using the Varimax method with Kaiser normalization, which is designed to maximize the variance of the output factor loadings squares by the variables for each factor. After the rotation of the factors, the situation becomes clearer - a meaningful economic interpretation is obtained.

The Kaiser criterion was used to substantiate the optimal number of factors according to which those factors are considered and are statistically significant, i.e. values greater than one.

According to the Kaiser criterion, 3 factors were selected for providing information management processes to the industrial enterprise in accordance with the activity development scenarios (Table 1).

Table 1. Statistical characteristics of the factors regarding the effectiveness ensuring of the formation of information process of industrial enterprise management according to the activity development scenarios

Factor	Own value	The variance percentage, %	Cumulative own values	The cumulative variance percentage, %
Pessimistic scenario				
1	2,38	38,14	2,38	38,14
2	1,96	31,41	4,34	69,55
3	1,23	19,71	5,57	89,26
Neutral scenario				
1	3,26	40,95	3,26	40,95
2	2,08	26,13	5,34	67,09
3	1,34	16,83	6,68	83,92
Optimistic scenario				
1	2,05	31,59	2,05	31,59
2	1,88	28,97	3,93	60,55
3	1,57	24,19	5,5	84,75

Source: author's calculations

The cumulative variance percentage in the pessimistic, neutral and optimistic scenarios for the development of industrial enterprises is 89,26%; 83,92% and 84,75% respectively. That is, the variance value is more than 80%, that testifies to the correctness of factor analysis and sufficient number of factors to ensure the effectiveness of the information management process formation on the industrial enterprise. The range of factors formed on the basis of factor loadings (Table 2). The indicator is included into the factor with which the load is statistically significant ($> |0.7|$). Factor loadings are interpreted as correlations between the factors for ensuring the efficiency of industrial enterprise management and the variables of the enterprise management objects.

It is possible to design several approaches to the organization of future activity in advance, by grouping the factors of the development scenarios of the enterprise activity. All necessary prerequisites and possible changes in the factors of influence are taken into account and agreed. Factoring the results of the implementation of a particular scenario is the basis for creating an enterprise management system in the process of developing an effective strategy for its functioning.

As a result of statistical processing of data within the framework of the information process of management of machine-building enterprises by sample range, it is possible to generalize qualitative and quantitative assessment and, as a consequence, to draw certain conclusions.

Thus, based on the calculation of the correlation coefficients between the values of the integral indicator of ensuring the effectiveness of information management processes of the industrial enterprise and the values of the selected factors, it was found that all factors are drivers of

activity development, because correlation coefficients have positive values for them: 0,75 - for the pessimistic scenario, 0,84 - for the neutral and 0,81 - for the optimistic. Among the indicators of the efficiency usage factor regarding the production means, which is a stimulation of the enterprise's activity development, the index of capital intensity has a negative value of factor loading, which testifies to the reverse influence on the development of the enterprise - destabilizing. Fundamentality shows how much the value of an enterprise's fixed assets is per unit of net income, that is, it is an inverse indicator of the efficiency of the fixed assets usage.

Table 2. Factor loadings of indicators regarding ensuring the effectiveness of the information process of managing an industrial enterprise under the activity development scenarios

Factor	Indicators	Factor loading
Pessimistic scenario		
Factor 1 - the factor of usage efficiency of production means	Labor productivity	0,98
	Capital productivity	0,74
	Capital intensity	-0,86
	Capital ratio	0,79
Factor 2 - the factor of material work encouragement	Average salary	0,82
	Average salary of full-time workers	0,75
	Working time fund for which salaries for full-time employees are calculated	0,88
Factor 3 - the factor of the enterprise solvency	Absolute liquidity coefficient	0,84
	Coefficient of coverage	0,96
	Autonomy coefficient	0,87
Neutral scenario		
Factor 1 - the efficiency usage of production means	Labor productivity	0,94
	Capital productivity	0,86
	Capital intensity	-0,75
	Capital ratio	0,84
	Average salary	0,86
Factor 2 - the solvency of the enterprise	Absolute liquidity coefficient	0,75
	Coefficient of coverage	0,84
	Autonomy coefficient	0,89
Factor 3 - material incentives for work	Average salary of full-time workers	0,84
	Working time fund for which salaries for full-time employees are calculated	0,76
Optimistic scenario		
Factor 1 - the solvency of the enterprise	Absolute liquidity coefficient	0,92
	Coefficient of coverage	0,90
	Autonomy coefficient	0,83
	Capital productivity	0,79
Factor 2 - the efficiency usage of production means	Labor productivity	0,90
	Capital intensity	-0,89
	Capital ratio	0,76
Factor 3 - material incentives for work	Average salary	0,83
	Average salary of full-time workers	0,91
	Working time fund for which salaries for full-time employees are calculated	0,86

Source: author's calculations

For the pessimistic scenario of enterprise development, the factor of efficiency of using the production means is the main factor for ensuring the effectiveness of the information process formation of industrial enterprise management.

In order to overcome the pessimistic scenario, the priority task of the management process is to ensure the usage efficiency of labor resources and fixed assets based on the growth of labor productivity, capital productivity, capital ratio and decrease in the capital intensity index.

One of the key factors for ensuring the efficiency of the information process formation of industrial enterprise management under the pessimistic scenario is labor productivity, the factor loading of which is 0.98.

Information on labor cost savings can be a major contributor to productivity growth in engineering enterprises. Scientific and technological progress plays a significant role, manifested in the following aspects: the usage of new technologies, the improvement of systems and machines, the introduction of complex mechanization, engineering communications necessary to perform technological processes, as well as leading technologies and scientific developments, which in turn contributes to the improvement labor productivity, modernization of existing equipment.

Organization informatization of production processes of the engineering enterprises also has a significant impact. It allows you to effectively manage production, find rational methods of performing operations and identify other important factors.

The scientific labor organization has significant potential reserves for improving labor efficiency with minimal additional material costs. The most effective usage of operating capacities, diversification of production, reduction of time losses, etc., have a significant impact. Moreover, it should be noted that the inherent indicator of low labor productivity level within the framework of the national industry in general, including for the surveyed enterprises, is staff turnover, which can be attributed to the employees' dissatisfaction with the working conditions, the size of their salary and their desire to satisfy their needs by obtaining a new working place.

The staff turnover that does not affect the general number of employees due to the recruitment of new employees is quite significant. However, new workers need to adapt to the new place of work, production conditions, even if it is an experienced worker; moreover, for those who first came to the company, it takes time to learn the job, and also experienced employee should to be attached to them, whose work efficiency, respectively, is also reduced.

The results of the study show that the indicators of capital productivity, capital intensity and capital ratio have a significant influence on the management of enterprises of the engineering industry under the pessimistic scenario of activity development. An analysis of the usage efficiency of fixed assets at enterprises showed that mainly the cost of sold products is increased due to the growth in amortization.

At the same time, calculated amortization for the renewal and expansion of production is not used, because every year the difference between the real depreciation and the financial recovery of fixed assets increases, which leads to a deterioration of their financial position and reduces management efficiency. Enterprises use direct method of amortization of fixed assets: they do not take into account the moral wear and tear and differences in the production capacity of fixed assets in different years of their operation, as well as the need to increase the cost of repair in recent years of service. In our opinion, the management of enterprises should change the direct method of amortization to accelerated, which in turn will accelerate the process of updating enterprise's fixed assets, accumulate sufficient funds for technical re-equipment and reconstruction of production, reduce income tax, maintain fixed assets at a high technical level.

The factor of usage efficiency of production means is also a priority under the neutral scenario of activity development of the enterprise, but its composition is supplemented by the indicator of average salary. In order to develop the activity under this scenario, it is necessary to ensure the efficiency of using the production means at the enterprise and to stimulate the employees by increasing salary.

Remuneration based on traditional wage systems, is ineffective in most cases in the process of meeting the requirement of fair payment system on the industrial enterprises. Remuneration based solely on tariff delimitation is often criticized for the lack of stimulus to increase productivity. A typical hourly form of remuneration is characterized by a lack of account of individual work achievements. Thus, in order to ensure the effective enterprise development under the neutral scenario, it is advisable to improve the performance measurement indicators by introducing a

system of motivating payments. Its main task should be to ensure that the amount of salary corresponds to the final market results at the enterprise and to the growth level in sales of goods in terms of expanding market demand for products. According to the optimistic scenario of the activity development of the enterprise, the priority factor at the stage of management is solvency of the enterprise, which includes the coefficient of absolute liquidity, coverage, autonomy, capital productivity.

The study also found that the lack of correlation between the major balance groups, the presence of significant problems with the timeliness of calculation operations adversely affect the solvency of industrial enterprises under the optimistic scenario of development.

In addition, an unsatisfactory structure of the equity was identified due to the existence of uncovered losses.

The enterprise management process should be aimed at optimizing reserves supplies, work in progress and finished products in order to increase solvency. Optimization of reserves levels should affect the redistribution of working capital of enterprises in an optimistic scenario, which will lead to the opportunity to increase the amount of liquid money and reduce the value of illiquid reserves.

The operational mechanism of financial stabilization can be used to optimize the liquidity of enterprises, that is, to create a system of measures aimed, on the one hand, to reduce financial liabilities and, on the other, to increase the monetary assets that support those obligations.

Thus, in order to summarize everything mentioned above, during any development scenario of the enterprise activity the list of factors for ensuring the effectiveness of the information processes formation of industrial enterprise management (for instance, on the enterprises of the engineering industry) remains constant: factor of usage efficiency regarding the production means, factor of material encouragement of labor, factor of the enterprise's solvency. The composition of the factors and their priority change slightly. Depending on the development scenario, the priorities of enterprise management change. Thus, during the implementation of pessimistic and neutral scenarios, the development of the enterprise's activity is possible by increasing the efficiency of using the production means, such as labor resources and production funds. As we move from a pessimistic to a neutral scenario, the role of the material component of an effective management system - the size of salary - increases. If the company develops under the optimistic scenario, the priority of the solvency factor increases.

The main purpose of the formation and usage of the information process of industrial enterprise management is to develop and then implement an effective activity strategy. Scenario planning is not just an invention in the field of enterprise development scenario, it is closely linked to strategic planning and management. The contribution of scenario planning to the further development of an enterprise strategy is that the selected scenarios allow for a reasonable set of alternative strategies, which in turn contributes to the optimistic result of any enterprise.

Nowadays, the lack of the advantages usage of the strategic approach in the management of industrial enterprises is caused not only by the instability of the political and economic situation in the country, but also by the inconsistency of the enterprises' philosophy with market conditions.

For instance, managers often form a view from the future to the present, develop recommendations for achieving results in the short term in the future, taking into account changes in the environment, often do not specify the medium and long-term actions for the future, lack of proactive action. Mostly, short-term development plans are used by enterprises, which significantly reduces the efficiency of their operation and provokes insolvency risks. Therefore, in order to improve the productivity of the management information process, deterministic liminal values of modifying the scenario approach to the development of engineering enterprises as a component of effective strategic management were formed. Since the restructuring processes at the enterprises are not considered in the work, the development of the enterprises is possible only in an evolutionary way, during which qualitative changes are implemented slowly and consistently. In this regard, achieving a high level of management efficiency through information processes during the implementation of the pessimistic development scenario is possible due to a consistent chain of

modifications from the pessimistic development scenario to neutral, as well as from neutral to optimistic, from optimistic to the target state. (high level of management efficiency).

If a neutral scenario is implemented, the modification chain has the following implementation algorithm: neutral scenario - optimistic, optimistic scenario - high level of management efficiency based on the usage of management information processes. Under the optimistic scenario of activity development, there are no intermediaries on the way to achieving high level of industrial enterprise management efficiency.

Using factor analysis, priority indicators in the management of an industrial enterprise were identified, providing modification to the neutral scenario of activity development and they are the following: labor productivity, capital efficiency, capital intensity, capital ratio.

Conclusion

Evaluation of management information processes involves the usage of the indicators set and makes it possible to analyze comprehensively and then consider the management information process. The proposed set of indicators for evaluating information management processes in an industrial enterprise takes into account all aspects and parameters of information processes not only by qualitative but also by quantitative criteria, and also contains a performance component that is based on economic parameters and allows to evaluate the whole set of labor indicators, financial and industrial spheres activities that reflect the state of the enterprise the most fully.

The influence of integrated indicators of labor, production and financial sphere on the index of ensuring the effectiveness of management information processes under different scenarios of development: pessimistic, neutral, optimistic was determined. This in turn provides the opportunity to form different scenarios for the development of enterprise activity and will allow to implement a preventive management function aimed at neutralizing the negative impact of destabilizing factors at different stages of enterprise's activity.

By using the tool of multivariate factor analysis, the factors of ensuring the effectiveness of the information process of managing an industrial enterprise that are dominant in different scenarios of its activity development, are determined. Thus, it was determined that for pessimistic and neutral scenario this factor is the efficiency of using the production means, and for the optimistic one - the factor of the enterprise's solvency.

Priority factors have also been developed that are appropriate to use when developing a methodological approach to improving the quality of an industrial enterprise's management process if a pessimistic, neutral or optimistic scenario for the development of an activity is implemented at the enterprise.

A methodological approach to evaluating the effectiveness of the information management process of an industrial enterprise has been developed on the basis of determining the limiting values of indicators that cause the transition of the enterprise from a pessimistic scenario of activity development to a neutral one, from a neutral to an optimistic one, which in turn gives the opportunity to determine the target parameters for the development of the enterprise, depending on the state of its current activity.

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