

Information and Analytical Support of Business Models and Management Systems of Enterprises in China and Russia in the Digital Economy

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Abstract

This work is devoted to the deepening of theoretical provisions, substantiation of the theoretical and methodological foundations for the formation of enterprise information processes and the development of practical recommendations for their use in the management of industrial enterprises in the context of the development of global economic relations.

The article has formed a system of indicators for assessing the effectiveness of the information management process in order to determine the possibility and feasibility of its use in the management of an industrial enterprise.

Indicators, the calculation of which is based on internal sources of information of an industrial enterprise according to management and financial accounting data, form the basis of the information process for managing the activities of an industrial enterprise. For the analysis, the data were combined with the subject area into indicators of labor, production and financial spheres.

In order to improve the process of managing an industrial enterprise, partial indicators of assessing the effectiveness of the information process of managing an industrial enterprise were calculated on the basis of the synthesis of expert assessment methods: by scores and the method of analyzing hierarchies.

Based on the results of the study, priority indicators have been identified for calculating the integral indicator of ensuring the effectiveness of the information process of managing an industrial enterprise with ensuring the reliability, content, completeness and relevance of the information process.

The factors that ensure the efficiency of the information process of enterprise management are identified, thanks to which it becomes possible to design in advance several approaches to organizing the future activities of an industrial enterprise.

Keywords: - information and analytical support, information process, business models, enterprise management, performance factors.

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Introduction

Today, to ensure effective management of industrial enterprises, it is necessary to first solve the problems of improving the quality of the information process in the management system, which is due to the continuous growth of the need for prompt, adequate, reliable, objective information of an economic, production, financial and other nature in the process of developing and implementing enterprise management policies.

The process of making a rational management decision or justifying its choice from a variety of alternative options in order to select a profitable direction for the development of an enterprise's economic activities, which requires timely and maximum complete information.

In this regard, the information support of the economic activity of the enterprise is one of the most important components of the information management process, which should include a continuous targeted selection of appropriate informative indicators for making appropriate management decisions on all aspects of the economic activity of the enterprise.

In addition, reliable and complete information is the basis for not only operational and tactical, but also strategic planning of the activities of economic entities.

Continuous development, constant analysis of the factors of influence of the information environment of the functioning of an industrial enterprise will increase the adaptability of the enterprise to the changing conditions of the external environment and ensure the efficiency of its activities in unfavorable conditions, increase its competitiveness.

Theoretical Framework or Literature Review

Problems and prospects for the development of the process of ensuring the effectiveness of the information management process are increasingly considered in the scientific literature. The authors of Ershova et al. (2019) in their work analyze such important issues as the essence of information, its components in the control system.

In the works of the authors (Dadaev, Magomedov (2019), Rolland, Hanseth (2021)), the process of forming a system of indicators for assessing the effectiveness of the information process, which are the basis of the management process, is considered. A detailed research in the field of information support was carried out by the authors (Dmitrieva, Koptelova (2020), Kadyrova (2018), Eremenko et al. (2018), Wei Wang (2022)). This scientific work explores the theoretical foundations of information support, assesses the state and development prospects, etc.

Justification of the need to use the information process in management based on the theory of "information explosion", which is the basis of the information management of an enterprise, was carried out by scientists (Filippova, Ushakova (2018), Nekhaichuk et al. (2019), Klyukin (2019)), Fengxiu Zhou (2022).

Features of the construction and effective functioning of an information system as an environment for the formation and implementation of information processes for managing an industrial enterprise are studied in the works of the authors (Khrustalev et al. (2019), Indan (2019), Esikov, Titov (2018), Shashlo (2020), Petruk (2020)).

However, with all the diversity of research in this area, not all theoretical and methodological aspects of information management processes necessary to improve the efficiency and quality of enterprise management, as well as the development of its activities, remain insufficiently studied.

At the same time, issues related to the assessment of the information management process, based not only on technical, qualitative and safety indicators, but also on the determination of their effectiveness, which can be used as a basis for criteria for sound management decisions, require clarification.

Methodology

The research was carried out by methods of scientific analysis of the phenomenon under study, namely: an abstract-logical method, a systematic approach, methods of analysis and synthesis - to clarify the information management process, to determine the system of its evaluation indicators; multidimensional factor analysis - to substantiate the system of indicators for the quantitative assessment of the effectiveness of information management processes at an industrial enterprise; method of expert assessments - to determine indicators of the effectiveness of information management processes based on information quality criteria and their significance; graphic - to visualize the results.

Results and Discussion

The indicators formed from internal sources of information of the enterprise according to the data of management and financial accounting form the basis of the information process of managing the economic activities of an industrial enterprise. For ease of use, it is advisable to combine the indicators with the subject area into indicators of the labor, production and financial spheres in accordance with the highest frequency of mentioning these groups of indicators in the works of scientists (Kovalenko, Ivanchenko (2018), Reshetko et al. (2021)).

The main indicators of labor sphere, obtained as a result of theoretical analysis, are: the size of the average wage (T1); the size of the average salary of full-time employees (T2); labor productivity (T3) working time fund, according to which wages are calculated for full-time employees (T4) personnel lapse factor (T5) the number of absenteeism (T6) the number of production personnel (T7) the total number of employees (T8).

Among the indicators of the production sphere, the following are usually analyzed: capital productivity (P1) capital-intensiveness (P2) capital-labor ratio (P3) gearing (leverage) ratio (P4); additions to fixed capital (to fixed assets) (P5) fixed capital depreciation ratio (P6) replacement cost of fixed asset (P7).

According to financial indicators, the following ratios were selected: cash ratio (F1), coverage ratio (F2), equity ratio (F3), return on assets (F4), asset turnover (F5), non-current assets value turnover (F6), current assets to equity ratio (F7), indicators of own working capital (F8).

Experts note the advantages of the scorecard as a source of information support for the management process of an industrial enterprise (Kostyukhin (2019), Shashlo N. et al. (2019)):

- unification based on generally accepted standardized accounting principles, which, in turn, allows the use of standard technologies and algorithms for financial calculations for certain aspects of the formation and distribution of financial resources, as well as to compare these indicators with other similar enterprises;
- the exact frequency of formation (within the established regulatory time frame);
- a high degree of reliability and reliability, that is, these indicators, as a source of information for

making management decisions, adequately reflect the real state and results of the enterprise's economic activity (reporting is formed on the basis of financial statements, is provided to external users and is subject to external audit);

- meaningfulness, ensuring the reflection of not only cost, but also natural values of indicators;
- significance, since the analysis of these indicators affects the results of financial decisions;
- timeliness, since indicators allow the formation of information for the corresponding periods of its use;
- comprehensibility, which is characterized by the simplicity of the formation of relevant information due to the proposed system of indicators, compliance with the standards of understanding by those categories of users for whom it is intended;
- relevance (selectivity), which determines a fairly high degree of use of the existing system of information indicators in the process of managing the activities of an industrial enterprise;
- comparability - determines the possibility of a comparative assessment of the cost and results of financial activities, the use of a comparative analysis of the company's activities according to specified indicators;
- efficiency assumes that the costs of attracting these information indicators do not exceed the effect obtained as a result of their use;
- stability, that is, the ability of management information to respond to changes in input data and maintain the required accuracy;
- completeness, when the number of indicators and their information content are sufficient to generate such a volume of information that is understandable and sufficient for making a rational management decision.

Considering the above, we can say that an important complex indicator of the quality of information is the indicator of information support in the process of managing an industrial enterprise, namely, an indicator that allows you to satisfy the information needs of the analysis of economic activities and, on this basis, make fundamental management decisions.

For example, in production management systems, the value of information is determined by the efficiency of economic management carried out on its basis, or by an increase in the economic effect from the functioning of the management system due to the pragmatic properties of information.

In this case, the unit of measurement of information is currency.

Any target management includes a combination of types of information-analytical support based on the relevant characteristics of the management objectives.

In general, we can say that the efficiency of using information processes in the management process depends and is characterized precisely by the completeness of information (C), which is inextricably linked with its reliability and with the timeliness of its processing in control systems.

The formalized efficiency of using the information process in the process of managing an industrial enterprise is characterized by certain conditions (formulas 1 and 2) (Beregova, Baoyu (2019)):

$$C = 1 \text{ for } \nu \geq \nu_{min} \quad (1)$$

or

$$C = 0 \text{ for } \nu < \nu_{min} \quad (2)$$

ν - the volume of processed information in the process of making a management decision;

ν_{min} - the minimum allowable volume of processed information, sufficient for making a management

decision.

Based on the generalization of literary sources (Davletova (2019), Mamoshina (2018)), within the framework of this study, it has been established and will be considered a prerequisite for using the information process in the process of managing an industrial enterprise (1).

In accordance with changes in the information needs of the enterprise management system, new requirements arise for the information support of the management decision-making process.

The information field should be characterized by relevance in the process of information processing and implementation of the enterprise information management process.

That is, it is necessary to maintain a balance between completeness and relevance in the formation of an information array.

Priority should be given to information that is really necessary for making management decisions. In addition, the balance between completeness and brevity is very important, which helps the decision-maker to quickly and accurately understand the decision.

It is precisely the brevity of information in the modern system of managing the activities of an industrial enterprise that is one of the priority requirements for the effective use of the information process.

The simultaneous use of these indicators as a source of information for making informed management decisions complicates the procedure for forming the information field and reduces the reliability of the results obtained due to the presence of multicollinearity between economic indicators.

Therefore, in this study, ensure the brevity of information support for the management process at the enterprises of the machine-building industry of the Rostov region (Rostselmash group of companies, «TKZ Krasny Kotelshchik» PJSC, Lemax LLC, «AEM-technology» «Atom mash» PJSC, «PK «NEVZ» LLC, «Salskselmash» LLC, Millerovoselmash PJSC), as well as Chinese companies - Midea Group, Gree Electric Appliances, Haier, Techtronic Industries, NARI Technology Development, Changhong Electric, the main qualitative characteristics of information were determined by an expert method, ensuring its completeness and brevity of the information array. 10 experts took part in the examination. The experts were selected for the study based on their official professional status - position, academic degree, work experience, etc. This choice contributed to the fact that the group of experts included highly professional specialists with extensive practical experience in this area. The expert assessment was carried out by interviewing leading experts in the field of information support for the management process at enterprises. The main issue of the discussion was the definition of the main qualitative characteristics of the information indicated in the study in order to achieve its brevity in the process of using the information process.

The interview method involved a conversation with a specialist-expert in a specific field of knowledge.

The advantages of this method are that the forecaster has the ability to refine and correct the answers during the conversation, ensuring the reliability of the results obtained during the research.

According to the results of the expert assessment, it was found that the overwhelming number of specialists (8 out of 10) determined the completeness, reliability, and the main qualitative characteristics of the information.

It is these indicators of information quality that make it possible to achieve effective use of the information process at machine-building enterprises, and it is these indicators that can be used to

achieve brevity of information.

The degree of consistency of experts' opinions, assessed by the coefficient of concordance at the level of 80%, indicates the reliability of the survey, when determining the priority criteria for evaluating information to achieve the efficiency of information processes of industrial enterprises (Zhaohui Yang, 2022).

To determine the indicators that are advisable to use in the management of an industrial enterprise, the method of expert assessment by T. Saati (Saati (1993)) was applied, based on a system of paired comparisons of certain characteristics at the hierarchy level. The hierarchy model consists of the following levels: purpose, criteria and alternatives. The purpose of the expert assessment is to determine the indicators for evaluating information processes and, accordingly, the possibility of their use in the management of an industrial enterprise according to the criteria of reliability, clarity, completeness, saturation. At the same time, completeness, reliability, appropriateness and brevity are the criteria of the model, the indicators themselves, revealed as a result of theoretical generalization of the literature, are alternative. The model of the priority hierarchy of indicators for assessing information management processes in the enterprise is shown in Figure 1.

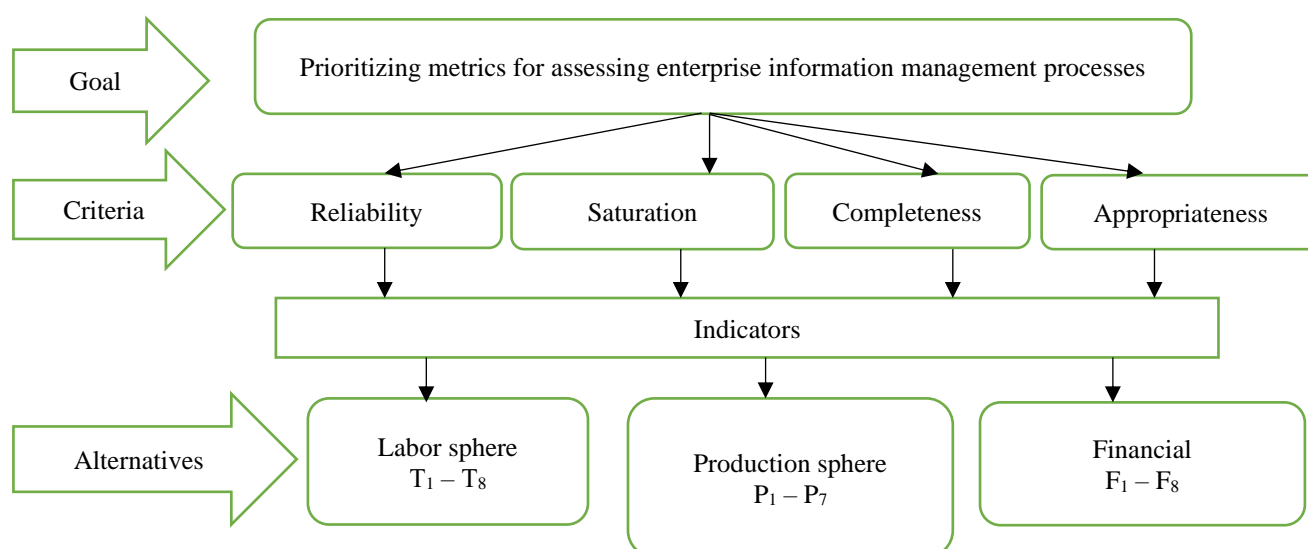


Figure 1. Model of the hierarchy of indicators for assessing enterprise management processes

The prioritization of indicators is based on the determination of the paired scores of the assessment criteria (Rodionov, 2020). The system of paired assessments of judgments using the method of hierarchical analysis by T. Saaty leads to a result that can be presented in the form of a mutually symmetric matrix (Table 1).

Table 1 - Matrix of pairwise comparisons of judgments by the method of hierarchical analysis T. Saaty

| Factor | 1 (j-th factor) | ... | n |
|------------------|-----------------|-----|----------|
| 1 (i- th factor) | 1 | | a (i, j) |
| ... | | 1 | |
| n | a (i, j) | | 1 |

The matrix element $a(i, j)$ is determined by comparing the importance of the i -th factor with the j -th factor on a scale of intensity from 1 to 9, where the scores have the following definition:

1 - equals importance;

3 - moderate predominance of the i -th factor over the j -th;

5 - essential advantage of the i -th factor over the j -th;

7 - significant advantage of the i -th factor over the j -th;

9 - a very strong advantage of the i -th factor over the j -th;

2, 4, 6, 8 - corresponding intermediate values.

The prioritization of criteria when choosing an alternative is carried out according to the formulas (3-4) (Osipov et al. (2018)):

$$W_i = \sqrt[n]{\prod_{j=1}^n a_{ij}} \quad (3)$$

$$W_{norm} = \frac{W_i}{\sum_{i=1}^n W_i} \quad (4)$$

W - component of the eigenvector of the matrix (average value of the priority estimate)

W_{norm} - normalized vector of a matrix of pairwise comparisons (priority vector)

a_{ij} - values of matrix elements.

The assessment of the consistency of expert opinions is carried out according to the formulas (5-7) (Antsev, & Vitchuk (2017)):

$$\lambda = \sum_{i=1}^n a_{ij} \times W_{norm\ i} \quad (5)$$

$$I_c = \frac{(\lambda - n)}{(n-1) \leq 0.2} \quad (6)$$

$$OC = \frac{I_c}{I_{cc} \leq 0.1} \quad (7)$$

λ - the eigenvalue of the matrix;

I_c - the consistency index;

I_{cc} - average value of the index of conformity;

OC - consistency relation;

n - the number of criteria (alternatives).

When conducting an expert assessment, summary results were obtained to determine the main qualitative criteria of information, which make it possible to substantiate the effectiveness of using the information process at a particular industrial enterprise (Table 2).

Table 2 - Relative significance of criteria for determining the priority of indicators when assessing the effectiveness of the information process of enterprise management

| Information quality criterion | Significance of the importance of the criteria | | | | | | | | | | |
|-------------------------------|--|----------|----------|----------|----------|----------|----------|----------|----------|-----------|------------------------|
| | Expert 1 | Expert 2 | Expert 3 | Expert 4 | Expert 5 | Expert 6 | Expert 7 | Expert 8 | Expert 9 | Expert 10 | Medium priority vector |
| Reliability | 0,36 | 0,33 | 0,41 | 0,39 | 0,41 | 0,25 | 0,34 | 0,28 | 0,38 | 0,37 | 0,35 |

| | | | | | | | | | | | |
|-----------------|------|------|------|------|------|------|------|------|------|------|------|
| Saturation | 0,14 | 0,18 | 0,12 | 0,12 | 0,15 | 0,23 | 0,16 | 0,18 | 0,14 | 0,16 | 0,16 |
| Completeness | 0,21 | 0,23 | 0,12 | 0,18 | 0,16 | 0,24 | 0,24 | 0,24 | 0,14 | 0,21 | 0,19 |
| Appropriateness | 0,29 | 0,26 | 0,35 | 0,31 | 0,28 | 0,28 | 0,26 | 0,3 | 0,34 | 0,26 | 0,30 |

According to expert estimates, an important criterion for assessing the effectiveness of the use of information processes in the management of an industrial enterprise is reliability (the legality of the origin of the information source and the correspondence of information to reality, the priority of which was 0.35), the second criterion in terms of importance is appropriateness (priority 0.30), the priority of the saturation and completeness – 0.16 and 0.19, respectively.

The next stage of the expert assessment is to prioritize indicators based on the qualitative criteria of information (Table 3).

Table 3 - Priority of indicators for assessing information processes according to information quality criteria

| Indicator | Average vector of priorities of information quality criteria | | | |
|----------------|--|------------|--------------|-----------------|
| | Reliability | Saturation | Completeness | Appropriateness |
| T ₁ | 0,22 | 0,22 | 0,21 | 0,20 |
| T ₂ | 0,21 | 0,21 | 0,20 | 0,17 |
| T ₃ | 0,20 | 0,18 | 0,21 | 0,21 |
| T ₄ | 0,21 | 0,15 | 0,20 | 0,13 |
| T ₅ | 0,04 | 0,04 | 0,05 | 0,07 |
| T ₆ | 0,04 | 0,10 | 0,05 | 0,05 |
| T ₇ | 0,04 | 0,04 | 0,04 | 0,07 |
| T ₈ | 0,04 | 0,05 | 0,03 | 0,09 |
| P ₁ | 0,27 | 0,27 | 0,21 | 0,23 |
| P ₂ | 0,27 | 0,20 | 0,23 | 0,24 |
| P ₃ | 0,26 | 0,19 | 0,20 | 0,23 |
| P ₄ | 0,04 | 0,10 | 0,10 | 0,08 |
| P ₅ | 0,05 | 0,10 | 0,08 | 0,08 |
| P ₆ | 0,05 | 0,10 | 0,08 | 0,07 |
| P ₇ | 0,05 | 0,04 | 0,07 | 0,06 |
| F ₁ | 0,24 | 0,22 | 0,23 | 0,21 |
| F ₂ | 0,26 | 0,31 | 0,28 | 0,24 |
| F ₃ | 0,21 | 0,23 | 0,21 | 0,23 |
| F ₄ | 0,05 | 0,05 | 0,07 | 0,10 |
| F ₅ | 0,06 | 0,05 | 0,05 | 0,05 |
| F ₆ | 0,05 | 0,04 | 0,05 | 0,06 |
| F ₇ | 0,07 | 0,04 | 0,04 | 0,05 |
| F ₈ | 0,03 | 0,03 | 0,05 | 0,04 |

The calculation of priorities was carried out separately for the indicators of the labor sphere, production and financial. Among the indicators of the labor sphere according to the criterion of

reliability, saturation and completeness, the priority indicator of the assessment is the size of the average wage (T1).

The priority of the indicator according to the specified criteria is 0.22, 0.22 and 0.21, respectively.

According to the appropriateness criterion, the highest priority is given to the labor productivity indicator (T3) - 0.21.

Of the indicators characterizing the production sphere, the priority for assessing information processes for the given key qualitative characteristics of information at the enterprise are the capital productivity (P1) capital coefficient (P2)

The average vector of information reliability priorities is 0.27 according to the criterion of content for P1 - 0.27; P2 - 0.20, according to the criterion of saturation of information for P1 - 0.22; P2 - 0.23

Among the group of financial indicators by all criteria, the coverage ratio (F2) prevails.

The priority of this indicator according to the criterion of reliability is 0.26, according to the criterion of saturation - 0.31, according to the criterion of completeness - 0.28, according to the criterion of appropriateness - 0.24.

The global priority of alternatives (indicators for assessing the effectiveness of information processes in order to determine the possibility of their use in enterprise management) is calculated on the basis of multiplying the matrix of priorities of alternatives for each of the criteria by the matrix of the priority of criteria, the results of which are presented in Table 4.

Table 4 - Priority of indicators for assessing information processes of enterprise management

| Indicator | Priority value (fraction of variance) | Indicator | Priority value (fraction of variance) |
|----------------|--|----------------|--|
| T ₁ | 0,21 | P ₅ | 0,07 |
| T ₂ | 0,19 | P ₆ | 0,07 |
| T ₃ | 0,2 | P ₇ | 0,06 |
| T ₄ | 0,17 | F ₁ | 0,22 |
| T ₅ | 0,05 | F ₂ | 0,26 |
| T ₆ | 0,05 | F ₃ | 0,22 |
| T ₇ | 0,05 | F ₄ | 0,07 |
| T ₈ | 0,05 | F ₅ | 0,05 |
| P ₁ | 0,24 | F ₆ | 0,05 |
| P ₂ | 0,24 | F ₇ | 0,05 |
| P ₃ | 0,23 | F ₈ | 0,04 |
| P ₄ | 0,07 | | |

According to the results of empirical research, it was determined that the highest priority for assessing information management processes at an enterprise according to qualitative criteria of content, reliability, completeness and relevance of information are indicators of the size of the average wage (T₁), priority value - 0.21, capital productivity (P₁) – 0.24 and capital-intensiveness (P₂), priority is 0.24 and coverage ratio (F₂) is 0.26.

The decision on the reliability of the sample of estimated indicators was made based on the value of

the percentage of the indicators' variance. The indicators within the groups were ranked in accordance with the value of the global priority. A sample for which the cumulative coefficient of variance is greater than 0.7 is considered sufficient. Thus, the assessment indicators are determined on the basis of their ranking according to the degree of priority and the choice of the number of indicators for which the aggregate percentage of variance will be at least 0.7, the next indicator, not included in the priority list, will be the percentage of variance, which is significantly lower than the previous one included in the priority ones (by analogy with Cattell's estimate in factor analysis).

Thus, the formed system of indicators for assessing information processes in order to determine the possibility of their use in the process of managing an industrial enterprise, fully reflecting such qualitative criteria of information as reliability, saturation, completeness and appropriateness, includes indicators of average wages (T1), the size of the average salary of full-time employees (T2), labor productivity (T3), the working time fund, according to which wages are calculated for full-time employees (T4), indicators of capital productivity (P1), capital-intensiveness (P2), capital-labor ratio (P3), cash ratio (F1), coverage ratio (F2) (table 4).

The cumulative percentage of variance of individual indicators of the labor sphere is 0.77, for indicators of the production sphere - 0.71, financial indicators - 0.7.

The value of the percentage of variance more than 0.7 indicates the completeness of the sample for assessing information management processes at the enterprise in order to achieve brevity of information.

The reliability of the expert assessment based on the MAI, T. Saaty is confirmed by the values of the coherence index, which do not exceed the standard value of 0.2, and the values of the coherence index - no more than 0.1, and the coefficient of concordance - 0.76. The value of the coefficient of concordance 0.74, indicates the coherence of expert opinions and the possibility of using the results of expert assessment. To ensure the effectiveness of the formation of the information process of managing an industrial enterprise, first of all, it is necessary to determine the priority directions of management. With the help of this goal, the study uses factor analysis aimed at identifying the factors that are used for each of the scenarios of enterprise development. Identification of these factors allows you to focus on improving the priority problem areas of the enterprise and determine the optimal values of information support indicators, compliance with these factors will help to improve the efficiency of enterprise management as a whole.

Taking into account the main disadvantages of existing integral methods for assessing the effectiveness of the formation of the information process of enterprise management, namely: the use of the method of expert assessments and the determination of an insufficient number of factors, the use of hard-to-reach data, within the framework of this study, the following requirements for the methodology for determining the priorities of enterprise management based on the formation of the information management process are determined:

- alignment of subjective assessment when calculating the final indicator or any component;
- taking into account as many factors as possible that affect the scenarios of the enterprise's development;
- the use of statistical data that determine the factors of ensuring the effectiveness of the formation of the information process of managing an industrial enterprise, which are reflected in the accounting and financial statements.

This approach ensures the availability of corporate data, the mathematical validity of the approach. Taking into account the above, the study carried out a factor analysis of the effectiveness of the formation of the information process of managing an industrial enterprise according to the scenarios of the economic development of its activities (on the example of industrial enterprises of the machine-building complex of the Rostov region).

To determine the factors of ensuring the effectiveness of the formation of the information process of managing an industrial enterprise, in the article, taking into account all the advantages of mathematical modeling, the method of principal components is used.

In contrast to simple methods of factor analysis, the method of principal components makes it possible to identify a sufficient and exhaustive number of characteristic factors of the phenomenon under study.

The advantage of using the method of principal components in comparison with the group method is that it does not require preliminary selection of groups of elementary features, which makes it possible to simplify the analysis.

The method of principal components differs from the method of principal factors in a much simpler logical construction, and at the same time, on its example, the general idea and goals of numerous methods of factor analysis becomes clear.

The method of principal components determines k component-factors that explain all the variance and correlation of the output k random variables; in this case, the components are formed in accordance with the decrease in the share, which they explain, the total variance of the output values allows us to restrict ourselves to a few first components.

The first main component F_1 determines the direction in the space of the output features along which the set of objects (points) has the greatest scatter (variance).

The second principal component F_2 is constructed so that its direction is orthogonal to the direction of F_1 , and this explains most of the residual variance, etc. to the k -th principal component F_k .

This transformation allows you to narrow the information array by discarding the coordinates corresponding to the directions with the minimum variance.

Thus, the use of the method of principal components makes it possible to build such an integral method for assessing the scenario of managing an industrial enterprise, which will be freed from subjective assessment and rely on a significant number of factors.

The factor is a latent indicator, it is constructed in such a way that the correlation between the set of available indicators can be explained.

Each factor analysis variable is expressed by a linear combination of hidden factors:

$$X_i = a_{i1} \times F_1 + a_{i2} \times F_2 + \dots + a_{im} \times F_m + U_i, \quad (8)$$

where X_i - indicator;

i is the number of indicators;

a_{im} factor loadings i for each m -th component;

m is the number of factors.

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

$$F_1 = b_{11} \times x_1 + b_{12} \times x_2 + \dots + b_{1k} \times x_k, \quad (9)$$

где b_i is the factor cost factor for x

The sample for factor analysis was compiled from the annual values of the indicators of the efficiency

of enterprise management for 2015-2019, on the basis of which an integral indicator of ensuring the efficiency of information processes in the management of an industrial enterprise was compiled: indicators of average wages (T1), the size of the average salary of full-time employees (T2), labor productivity (T3), the working time fund, according to which wages are calculated for full-time employees (T4), indicators of capital productivity (P1), capital-intensiveness (P2), capital-labor ratio (P3), cash ratio (F1), coverage ratio (F2), equity ratio (F3). The analysis was carried out using the values of the above system of indicators for the studied enterprises of the machine-building industry of the Rostov region.

The method of principal components was carried out using the Statistica 13.2 program.

To improve the results of the factors and get a solution that will have an economic interpretation, it is recommended to rotate the factors. The rotation of the coordinate axes was carried out using the Varimax method with Kaiser normalization, which is designed to maximize the variance of the squares of the loadings of the output factor over the variables for each factor. After the rotation of the factors, the results become more meaningful - a meaningful economic interpretation is obtained. When organizing the management of an industrial enterprise on the basis of assessing the effectiveness of the information process, it is necessary to take into account the properties of information, which in management consider its ability as a means of displaying processes, events, phenomena, as well as the possibility of reuse [Maksimenko&Malinina 2018].

To substantiate the optimal number of factors, the Kaiser criterion was used, according to which those factors are taken into account and are statistically significant, the eigenvalue of which is greater than one.

According to the Kaiser criterion, 3 factors were selected that ensure information processes in the management of an industrial enterprise in accordance with the scenarios of the development of activities (Table 5).

Table 5 - Statistical characteristics of the factors that ensure the effectiveness of the formation of the information process of industrial enterprise management according to the scenarios of the development of activities

| Factor | Eigen value | Percentage of variance, % | Cumulative eigen values | General percentage of deviation, % |
|----------------------|-------------|---------------------------|-------------------------|------------------------------------|
| 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 |

The cumulative percentage of the variance of the pessimistic, neutral and optimistic scenarios for the development of the activities of the industrial enterprises under study is 89.26%; 83.92% and 84.75% respectively.

That is, the value of the variance exceeds 80%, which indicates the adequacy of factor analysis and a certain sufficient number of factors to ensure the effectiveness of the formation of the information process of managing an industrial enterprise. The composition of the factors is formed on the basis of factor loadings (Table 6).

The indicator is included in the coefficient at which the load is statistically significant ($> |0.7|$).

Factor loads are interpreted as the relationship between factors that ensure the efficiency of industrial enterprise management and variable objects of enterprise management.

Table 6 - Factor loads of indicators of the efficiency of the information process of the management activities of an industrial enterprise according to development scenarios

| Factor | Indicators | Factor load |
|---|--|-------------|
| Pessimistic scenario | | |
| Factor 1 - the coefficient of efficiency of the use of production means | Labor productivity (T_3) | 0,98 |
| | Capital productivity (P_1) | 0,74 |
| | Capital-intensiveness (P_2) | -0,86 |
| | Capital-labor ratio (P_3) | 0,79 |
| Factor 2 - the factor of material incentives for labor | Size of the average wage (T_1) | 0,82 |
| | Size of the average salary of full-time employees (T_2) | 0,75 |
| | Working time fund, according to which wages are calculated for full-time employees (T_4) | 0,88 |
| Factor 3 - the factor of the company's solvency | Cash ratio (F_1), | 0,84 |
| | Coverage ratio (F_2) | 0,96 |
| | Equity ratio (F_3) | 0,87 |
| Neutral scenario | | |
| Factor 1 - the coefficient of efficiency of the use of production means | Labor productivity (T_3) | 0,94 |
| | Capital productivity (P_1) | 0,86 |
| | Capital-intensiveness (P_2) | -0,75 |
| | Capital-labor ratio (P_3) | 0,84 |
| | Size of the average wage (T_1) | 0,86 |
| Factor 2 - the factor of the company's solvency | Cash ratio (F_1) | 0,75 |
| | Coverage ratio (F_2) | 0,84 |
| | Equity ratio (F_3) | 0,89 |
| Factor 3 - the factor of material incentives for | Size of the average salary of full-time employees (T_2) | 0,84 |

| | | |
|--|--|-------|
| labor | Working time fund, according to which wages are calculated for full-time employees (T_4) | 0,76 |
| Optimistic scenario | | |
| Factor 1 - the factor of the company's solvency | Cash ratio (F_1) | 0,92 |
| | Coverage ratio (F_2) | 0,90 |
| | Equity ratio (F_3) | 0,83 |
| | Capital productivity (P_1) | 0,79 |
| Factor 2 - the coefficient of the efficiency of using the means of production. | Labor productivity (T_3) | 0,90 |
| | Capital-intensiveness (P_2) | -0,89 |
| | Capital-labor ratio (P_3) | 0,76 |
| Factor 3 - the factor of material incentives for labor | Size of the average wage (T_1) | 0,83 |
| | Size of the average salary of full-time employees (T_2) | 0,91 |
| | Working time fund, according to which wages are calculated for full-time employees (T_4) | 0,86 |

With the help of groups of factors of scenarios for the development of an enterprise, it becomes possible to design in advance several approaches to organizing activities. This takes into account all the necessary prerequisites and possible impact factors. Factorization of the implementation of this scenario forms the basis of the enterprise management system in the process of developing an effective functioning strategy. Summarizing the qualitative and quantitative assessment as a result of statistical data processing within the information process of management of machine-building enterprises in the sample population, certain conclusions can be drawn. So, based on the calculation of the correlation coefficients between the values of the integral indicator of ensuring the efficiency of information processes in the management of an industrial enterprise and the values of the selected factors, it was established that all factors are stimulators of the development of activities, since for them the correlation coefficients have positive values: 0.75 - for the pessimistic scenario 0.84 for neutral and 0.81 for optimistic.

From the composition of the indicators of the factor of the efficiency of the use of the means of production, which is a stimulator of the development of the enterprise, the indicator of capital-intensiveness has a negative value of the factor load, which indicates the opposite effect on the development of the enterprise - a destabilizing one. Capital-intensiveness is the inverse indicator of the efficiency of using fixed assets, since it shows what part of the value of fixed assets of an enterprise falls on a unit of net profit.

For the pessimistic scenario of the development of the activities of the studied machine-building enterprises, the determining factor in ensuring the effectiveness of the formation of the information process of managing an industrial enterprise is the factor of the efficiency of using the means of production. To exit the enterprise from the pessimistic scenario, the primary task of the management process is to ensure the efficient use of labor resources and fixed assets based on the growth of labor productivity (T_3), capital productivity (P_1), capital-labor ratio (P_3) and a decrease in capital-

intensiveness (P2). One of the key factors in the effectiveness of the formation of the information process of industrial enterprise management according to the pessimistic scenario is labor productivity, the factor load of which is 0.98. Labor productivity at industrial enterprises in Russia today is characterized by a rather low level compared to other sectors of the economy. As of the end of 2018, the index of labor productivity in industry was 105%, while the level and dynamics of labor productivity depend on the output in a given volume and range, production costs and the level of profitability of the enterprise, the number of employees, etc.

The main reasons for this state can be attributed to the fact that the structure of industry in Russia has deteriorated significantly as a result of an increase in the share of ferrous metallurgy and the fuel and energy complex and a decrease in the share of machine-building products.

In addition, such macroeconomic factors as a decrease in the purchasing power of the Russian currency, the priority of investing in fixed assets of the financial sector and trade, as well as a significant level of moral and physical deterioration of the industry's fixed assets, are significantly affected by the low level of labor productivity at industrial enterprises. With the current intensity of renewal of fixed assets in industry at the level of 4.5% per year, with a wear rate of 60%, a complete replacement of production equipment takes 25-35 years, which leads to a drop in production efficiency and a decrease in labor productivity. Information about the possibilities of saving labor costs can become a reserve for the growth of labor productivity at machine-building enterprises.

Scientific and technological progress plays a significant role: the use of new technologies, the improvement of systems and machines, the introduction of comprehensive mechanization, engineering communications necessary for the implementation of technological processes, as well as advanced technologies and scientific developments that contribute to the creation of an increase in labor productivity and the modernization of existing equipment.

The informatization of the organization of the production process of machine-building enterprises has a significant impact. It allows for perfect production management, finding rational methods for performing operations and identifying other important factors. The scientific organization of labor covers significant potential reserves for increasing labor productivity with minimal additional material costs. The maximum use of existing capacities, diversification of production, reduction of losses of working time, have a significant impact etc.

It should also be noted that a characteristic factor of the low level of labor productivity for the Russian industry, including the studied machine-building enterprises, is staff turnover, the main reasons for which can be attributed to workers' dissatisfaction with working conditions, wages and their desire to satisfy their needs by switching to new place of work.

The staff turnover is significant, which does not affect the decline in the number due to the recruitment of new employees. But new workers need to adapt to a new place of work, production conditions, even if it is an experienced worker; for those who came to the enterprise for the first time - in addition to the fact that they themselves need time to master the work, it is necessary to attach a mentor to them, whose work efficiency, accordingly, also decreases.

The results of the study indicate that the indicators of capital productivity (P1), capital-intensiveness (P2) and capital-labor ratio (P3) have a significant impact on the management of enterprises in the machine-building industry according to the pessimistic scenario of the development of activities.

An analysis of the efficiency of using fixed assets at the studied enterprises showed that the cost of

goods sold increases mainly due to an increase in depreciation.

At the same time, the accrued depreciation is not used for the restoration and expansion of production, therefore, every year the gap between the actual depreciation and the efficiency of restoration is increasing, which leads to a deterioration in their financial situation and reduces the efficiency of management.

Enterprises use a linear method for calculating the depreciation of fixed assets: obsolescence and differences in the production capacity of fixed assets in different years of their operation, the need to increase repair costs in recent years of service are not taken into account.

The authors believe that the management of enterprises should change the method of linear depreciation to accelerated, which will allow: to accelerate the process of renewal of fixed assets; to accumulate sufficient funds for technical re-equipment and reconstruction of production; reduce income tax; maintain fixed assets at a high technical level.

In the neutral scenario of the enterprise development, the priority is also the factor of the efficiency of using the means of production, however, the indicator of the size of the average wage (T1).

To develop activities under this scenario, the enterprise needs to improve the efficiency of the use of means of production and stimulate income growth by increasing wages. The wages are of paramount importance in the motivational mechanism of industrial enterprises. Almost 70% of the expenses of US enterprises are directed to the wages of workers, while in Russia this figure reaches only 40-50%. Compensation based on traditional wage systems, as practice has shown, is in most cases ineffective to meet the requirement to ensure fair wages in industrial enterprises.

Rewards based solely on a pay scale are often criticized for providing little incentive to improve productivity. The typical hourly form of remuneration is characterized by insufficient consideration of individual labor results. Therefore, in order to ensure the effective development of the enterprise according to the neutral scenario, it is advisable to improve the performance assessment indicators by introducing a stimulating remuneration system.

Its main task should be to ensure that wages correspond to the final market results of production at the enterprise and the growth of sales of goods in the context of expanding market demand for products.

At the stage of enterprise development according to the optimistic scenario, the priority factor of management is the factor of the company's solvency, including the cash ratio (F1), coverage ratio (F2), equity ratio (F3), capital productivity (P1).

The study also showed that compliance with an optimistic scenario for the development of activities negatively affects the solvency of industrial enterprises, with the interconnection of the main balance groups, the presence of significant problems with ensuring the timeliness of settlement operations. In addition, an unsatisfactory structure of equity capital was revealed due to the presence of uncovered losses. To increase the level of solvency of the studied enterprises, management measures should be aimed at optimizing stocks of materials, work in progress and finished goods.

Optimization of the level of inventories should affect the redistribution of working capital of enterprises according to the optimistic scenario of development, as a result of which it will be possible to achieve an increase in the amount of liquid funds and a decrease in the number of illiquid inventories.

Optimization of the liquidity of enterprises can be carried out with the help of the existing financial

stabilization mechanism - a system of measures aimed, on the one hand, at reducing financial obligations, and on the other, at increasing the funds that secure these obligations.

Thus, on the basis of the foregoing, it can be argued that, regardless of the enterprise development scenario, the list of factors that ensure the effectiveness of the formation of information processes in the management of an industrial enterprise (for example, mechanical engineering) remains unchanged: the factor 1 - the factor of the company's solvency (Fa1), the factor 2 - the coefficient of the efficiency of using the means of production (Fa2), the factor 3 - the factor of material incentives for labor (Fa3).

The composition of factors and their priority are changing somewhat. Depending on the development scenario, the priorities of the enterprise management change. So, in the implementation of pessimistic and neutral scenarios, the development of the enterprise's activities is possible by increasing the efficiency of using the means of production, such as labor resources and production assets. As the transition from a pessimistic to a neutral scenario increases the role of the material component of an effective management system - the size of the average wage (T1).

If the enterprise develops according to the optimistic scenario, the priority of the solvency ratio increases.

Conclusions

The main conclusions and recommendations based on the results of the study are as follows.

Within the framework of the study, it was determined that the main criteria for the quality of the information management process, indicating the possibility of its use in the management process at the enterprises of the machine-building industry, are reliability, saturation, completeness and appropriateness.

In the context of a constant change in information needs, new requirements for information service systems arise, namely: along with ensuring its operability, the task of achieving a compressed volume of the information array is actualized.

The existing system of performance indicators using the example of enterprises in the engineering industry can ensure the brevity of the information array, which, in turn, will indicate the expediency of using the information process in the process of managing an industrial enterprise. Determining the factors of ensuring the effectiveness of the information process of managing an industrial enterprise, dominating in various development scenarios, is an important stage in assessing the activities of an enterprise. So, at the stage of a pessimistic and neutral scenario, the development of an enterprise is possible by increasing the efficiency of using means of production, such as labor resources and production assets. In the transition from a pessimistic scenario to a neutral one, the role of material incentives - the size of wages - increases. If the company develops according to the optimistic scenario, the priority of the solvency ratio increases. The identified dominant factors allow influencing the state of the enterprise and leveling its sensitivity to changes.

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