# INFORMATION SYSTEM FOR FORMING STRATEGIC ALTERNATIVES FOR THE DEVELOPMENT OF AN INDUSTRIAL ENTERPRISE

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For major shareholders and heads of industrial enterprises, one of the main problems that they need to address in order to strategically develop these enterprises is the formation of a group of strategic alternatives for the development of the company. However, justifying and choosing the strategic alternative that should ensure the mainstream of this development is also a very complex problem.

The article presents a brief description of the information system developed by the author for the formation of strategic alternatives for the development of industrial enterprises, based on two mathematical models.

The first of them allows to calculate the dynamics of factors affecting the industrial enterprise, as well as its performance indicators.

The second model makes it possible to form a set of alternatives to the company's strategic development based on the results of calculating the first model, which allows its owners and managers to make their informed choice based on selected criteria.

The use of this information-analytical system in consulting practice produced good results.

*Keywords: information system, mathematical models, strategic alternative, development management, industrial enterprise.*

## 1. Introduction

In conditions of growing global instability in the constantly changing trends and trends in world markets, the need for qualitative analysis and a sound choice of management alternatives for the strategic development of enterprises and organizations acquires a key role for their survival and development. Unfortunately, there are no such systems in industrial enterprises yet. In addition, the vast majority of methods, models and algorithms aimed at improving the effectiveness of preparation for the adoption of managerial decisions for industrial enterprises [1–5, 7–9], can not be used in the current political, economic, financial and social instability , Since they do not provide an opportunity to carry out an analysis of the performance indicators of enterprises and organizations quite quickly and reasonably, let alone evaluate and select various alternatives for their development.

Analysis of tasks and factors associated with the formation of management decisions that ensure the effective operation of industrial enterprises and organizations shows that the management of industrial enterprises in modern conditions poses to owners and managers the task of increasing the efficiency and flexibility of management, as well as the reasonableness of the decisions made while ensuring the required quality of processing Large amounts of information. These considerations compel management to prepare management decisions based on new information systems, more adequate mathematical models, techniques, tools and technologies to increase management flexibility and efficiency, as well as modern tools for analyzing and presenting data.

## 2. Information system for the formation of strategic alternatives for the development of industrial enterprises

The basis of the information system developed by the author of the formation of strategic alternatives to the development of industrial enterprises is based on two mathematical models.

The first of them allows to calculate the dynamics of factors affecting the industrial enterprise, as well as its performance indicators.

The second model makes it possible to form a set of alternatives to the company's strategic development based on the results of calculating the first model, which allows its owners and managers to make their informed choice based on selected criteria.

Especially relevant such systems can be for large industrial enterprises and corporations that sell their products on foreign markets. In these cases, the number of factors influencing the choice of the company's behavior strategy is large enough, and the impact they exert on the organization is not always unambiguous.

Let us consider the fundamental essence of the model for calculating and analyzing the dynamics of factors, various impacts on an industrial enterprise and its performance indicators.

The formalization of the task and the decision-making process is connected with the improvement of the quality of processing procedures for operational information, the improvement of algorithms for forecasting the main factors, and the definition of adequate objective functions of models and criteria for their effectiveness.

The content of this model, in this connection, includes forecasting the cost of each type of resources used in the production of finished products, as well as many other factors affecting the company's operations. On this basis, the objective function is optimized, which can be chosen to maximize the profit received by the enterprise (organization) as a result of production and sale of products, or minimize losses to the enterprise during its production activities, etc.

### 3. Forecasting economic factors

Ensuring the flexibility and accuracy of forecasting economic factors affecting the incomes and costs of an industrial enterprise (organization) is provided through a variety of approaches for forecasting mathematical series. The use of this or that approach for forecasting is determined by the analytical department of the enterprise on the basis of historical data and an expert evaluation of the possible dynamics of the factor.

Among the various prediction methods for solving this problem, you can use both intuitive and formalized methods.

As you know, intuitive forecasting is used when mathematical modeling can not be used for various reasons (high complexity of formalization, lack of initial data, etc.). In these cases, it is possible to resort to a survey of experts. The individual and collective peer reviews obtained are used as final projections or as input data in complex forecasting systems.

Formalized forecasting methods provide forecasting using mathematical modeling. The application of these methods in practice increases the accuracy of forecasts, speeds up the processing and visualization of information, facilitates the evaluation of results.

The methods used in the mathematical model of the choice of management alternatives can be divided into several groups:

– regression prediction models: pair regression; multiple regression; models of discrete (binary or multiple) choice;

– autoregressive prediction models: ARIMA models, GARCH-models;

– adaptive prediction methods: exponential smoothing; Holt model; Holt-Winters model;

– neural network models: networks of direct distribution, recursive networks;

– models based on Markov chains;

– models based on classification and regression trees.

The corresponding mathematical equations and formulas are available in the specialized literature, and their description for the problem of calculating the dynamics of factors affecting industrial enterprises is described in detail in [6].

To form a forecast of the dynamics of indicators that affect the efficiency of an industrial enterprise or organization, it is necessary to select an adequate forecasting model for each factor. This can be done on the basis of the following algorithm:

Block 1. Determination of the set of suitable forecasting models (methods) based on Table 1. If the set is non-empty, block 2, otherwise block 10.

Block 2. Set an acceptable percentage of the prediction error $a$.

Block 3. Choose the first method of forecasting.

Block 4. Determine the percentage of error b in the control sample for the selected model.

Block 5. Checking $a$ > b? If yes, block 6, otherwise end.

Unit 6. Check: the latest model? If yes, block 7, otherwise block 8.

Block 7. Check: an increase in a is allowed? If yes, block 9, otherwise block 10.

Block 8. Choose the next forecasting method, go to the block 4.

Block 9. Zoom in a. Go to block 3.

Block 10. Expert assessments.

Block 11. The end.

The expediency of applying various forecasting models is reflected in Table. 1. The values given in the columns (0; 0.5; 1) indicate that, under the existing conditions, this or that model is appropriate to apply (1), it is possible to apply it to a limited extent (0.5), it is inadvisable to apply (0).

<div align="right">Table 1</div>

**The usefulness of the models under certain conditions**

| Class of models | Short-term | Middle-term | Long-term | Only linear processes | Calculation intensity | Solution verifiability | Practical implementation |
|---|---|---|---|---|---|---|---|
| Regression models | 0.5 | 0.5 | 1 | 1 | 0 | 1 | 1 |
| Autoregressive models ARIMAX | 1 | 0.5 | 0 | 1 | 0 | 1 | 1 |
| Autoregressive models GARCH | 1 | 0.5 | 0 | 1 | 0 | 1 | 1 |
| Exponential smoothin models | 0.5 | 1 | 0 | 0 | 0 | 1 | 1 |
| Neural networks | 1 | 1 | 1 | 0 | 1 | 0 | 1 |
| Markov chains models | 1 | 1 | 1 | 1 | 1 | 1 | 0.5 |
| Classification and regression trees models | 1 | 1 | 1 | 0 | 1 | 0 | 0.5 |

Once adequate forecasting models have been selected for all the main indicators that can affect the results of the enterprise (organization), it becomes possible to select the objective functions and criteria for the optimal choice of management alternatives for the strategic development of an industrial enterprise (the second model).

In this case, you can use a fairly large list of targets and applied restrictions, for example, such as:

– maximization of sales for a given profit;

– minimization of losses for a given volume of production;

– minimization of stock at a given volume of production;

– maximization of profit at performance of the production plan of release of production.

### 4. Optimization of the choice of strategic management alternatives
### for the development of an industrial enterprise

In general, the task of optimizing the choice of strategic management alternatives for the development of an industrial enterprise (organization) is formulated as follows.

Consider the problem of choosing from an alternative solution (hereinafter alternative), which allows you to get the maximum profit of an industrial enterprise for a given planning horizon. Denote $P_a(S)$ – the profit obtained as a result of the implementation of the alternative a in the selected scenario of development $S$.

In this case, you can calculate $P_a(S)$ using the expression:

$$P_a(S) = \sum_{i=1}^{Z} y_{ai}(S) \cdot r_i(S) - \sum_{i=1}^{Z} \sum_{j=1}^{B} w_j \cdot x_{aji} \cdot y_{ai}(S) - V_a, \tag{1}$$

where $B$ – the number of factors of production for which the forecast is built;

$Z$ – number of periods on which the forecast of indicators is built;

$x_{ajz}$ – the forecast of the cost of factor j with the chosen alternative $a$ in year $z$;

$y_{az}(S)$ – the forecast of output with the chosen alternative $a$ in year $z$, depending on the chosen scenario of development $S$ (for example: negative, moderate, positive);

$r_z(S)$ – forecast of the unit cost per year $z$;

$V_a$ – constant costs for the implementation of the alternative $a$;

$w_i$ is the factor i consumption in units of output per unit output.

Then the objective function is determined by the finding of a management alternative, which will result in the maximum profit in the selected scenario $S$.

$$\Phi = \max\{P_a(S)\}. \tag{2}$$

The search for optimal solutions in this situation can be carried out using a simulation model, the algorithm of which is as follows:

Block 1. Select the planning horizon and the selection criterion.

Block 2. Set the number of repetitions $X$.

Block 3. $S = 0$, select the first alternative.

Block 4. Selection of the first variable resource.

Block 5. Generate the script for the selected resource.

Block 6. Getting forecasts for the chosen alternative, resource, scenario.

Block 7. Verification: Are all resources selected? If yes, block 8, otherwise select the next resource and go to block 5.

Block 8. Calculation of profit for a given alternative and planning horizon using formula (1).

Block 9. $S = S + 1$. Check: $S < X$? If yes, Block 4, otherwise block 10.

Block 10. Save the estimated profit for this planning horizon and this alternative.

Block 11. Check: Are all alternatives selected? If yes, block 12, otherwise $S = 0$; Select the next alternative and go to block 4.

Block 12. Choose a better alternative based on the selected criterion and the resulting profit values.

If you calculate the profit for each alternative and planning horizon a sufficiently large number of times, you can choose the optimal alternative based on the highest average profit or any other criterion.

In the event that the probability of a scenario to calculate or ask expertly is problematic, one can use decision-making methods in conditions of uncertainty. The main criteria used in decision-making under uncertainty are presented below.

The Wald criterion (the "maximin" criterion) is characterized by an extremely cautious position regarding the uncertainty of the result:

$$Z_{MM} = \max_i\{K_i\}, \tag{3}$$

where $i$ is a variant of a possible decision of a decision maker ($i = 1, 2, ..., m$);

$j$ is a variant of a possible situation ($j = 1, 2, ..., n$);

$a_{ij}$ – income / profit of the decision maker, if a decision is made $i$, and the situation develops $j$-th;

$A = (a_{ij})$ – utility matrix.

The criterion of "maximal" is characterized by the extremely optimistic position of the attitude of the decision-maker to the uncertainty of the result:

$$Z_H = \max_i\{K_i\}, \tag{4}$$

where $K_i = \max_i\{a_{ij}\}$,

$i$ is a variant of a possible decision of a decision maker ($i = 1, 2, ..., m$);

$j$ is a variant of a possible situation ($j = 1, 2, ..., n$);

$a_{ij}$ – profit / profit of the decision maker, if a decision is made $i$, and the situation is $j$-th;

$A = (a_{ij})$ – utility matrix.

The Hurwitz criterion (the criterion of "optimism-pessimism" or "alpha-criterion") is a weighted position of "pessimism-optimism", reflecting the attitude of the decision maker to the uncertainty of the economic result:

$$Z_{HW} = \max_i\{K_i\}, \tag{5}$$

where $K_i = c \cdot \min_j\{a_{ij}\} + (1 - c) \cdot \max_j\{a_{ij}\} \cdot \max_j\{a_{ij}\}$;

$i$ is a possible choice ($i = 1, 2, ..., m$), $j$ is a possible situation ($j = 1, 2, ..., n$);

$c$ is the corresponding weighting factor chosen by the decision maker, Income / profit of DM, if a decision is made $i$, and the situation is $j$-th;

$A = (a_{ij})$ – the utility matrix.

The Savage criterion (the criterion for losses from the "minimax") is characterized by the extremely cautious (pessimistic) position of the attitude of the decision maker to possible losses due to the lack of reliable information about which of the situations affecting the outcome will take place in the specific case:

$$Z_S = \min_i\{K_i\}, \tag{6}$$

where $K_i = \max_j\{l_{ij}\}, l_{ij} = \max_j\{a_{ij}\} - a_{ij};$

$c$ – the corresponding weight coefficient chosen by the decision maker;

$i$ is a possible decision of a decision maker ($i = 1, 2, ..., m$);

$j$ is a possible situation ($j = 1, 2, ..., n$);

$a_{ij}$ – profit / profit of the decision maker, if a decision is made $i$, and the situation is $j$-th;

$A = (a_{ij})$ – utility matrix;

$L = (l_{ij})$ – the corresponding loss and risk matrix.

The described mathematical models are realized in the form of information-analytical system [6]. medium-term development objectives and strategies can be evaluated using other forecast models, as well as subjected to a multifaceted sensitivity analysis based on a change in the forecasting or planning horizon, changing the weight of each factor, estimating the influence of forecast accuracy and possible deviations [10–15].

**Conclusion**

Advantages of the proposed approach is the possibility of using variational prediction methods and the ability to adapt to the complexity and frequency of the need to solve a particular management problem.

Application of the presented system of analysis and choice of management alternatives on the basis of forecasting the dynamics of situations provides the flexibility and promptness of making managerial decisions that is so necessary in the current conditions of activity of industrial enterprises and organizations.

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# ИНФОРМАЦИОННАЯ СИСТЕМА ФОРМИРОВАНИЯ СТРАТЕГИЧЕСКИХ АЛЬТЕРНАТИВ РАЗВИТИЯ ПРОМЫШЛЕННОГО ПРЕДПРИЯТИЯ

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Для главных акционеров и руководителей промышленных предприятий одной из главных проблем, которые им необходимо решать в целях стратегического развития этих предприятий является формирование группы стратегических альтернатив развития компании. При этом обоснование и выбор той стратегической альтернативы, которая должна обеспечить мейнстрим этого развития также является весьма сложной проблемой.

В статье представлено краткое описание разработанной автором информационной системы формирования стратегических альтернатив развития промышленных предприятий, в основу, которой положены две математических модели.

Первая из них позволяет рассчитывать динамику факторов, оказывающих воздействие на промышленное предприятие, а также показателей его деятельности.

Вторая модель дает возможность на основе результатов расчета первой модели сформировать набор альтернатив стратегического развития компании, что позволяет ее собственникам и руководителям осуществлять их обоснованный выбор на основе избранных критериев.

Использование данной информационно-аналитической системы в консалтинговой практике дало хорошие результаты.

*Ключевые слова: информационная система, математические модели, стратегическая альтернатива, управление развитием, промышленное предприятие.*

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