

ISCKMC 2020
International Scientific Congress «KNOWLEDGE, MAN AND CIVILIZATION»
**ALGORITHM FOR MAKING MANAGEMENT DECISIONS IN A
DIGITAL ENTERPRISE**

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Abstract

Modern processes in the economy are characterized not only by openness, dynamism, the presence of a large number of connections, a huge number of factors of influence, but also a high degree of uncertainty. Diversity and a large amount of information, especially in relation to possible future scenarios and their development, do not always contribute to choosing the right solution, but only increase the degree of uncertainty and risk. The desire of managers to curb the uncertainty, reduce the risk, choose the right decision is dictated not only by psychological characteristics of a person, the desire to organize and explain what is happening, but the desire to predict the future scenario, make the right choice and to benefit from their labors. The article describes the algorithm of the program for making optimal management decisions in a digital enterprise under conditions of uncertainty and risk. The difference between this algorithm and traditional methods is a combination of system dynamics and agent modeling, which allows you to increase the accuracy of forecasting trends in the development of the external environment and, consequently, optimize the process of developing management decisions by managers. This algorithm is used in the management of industrial enterprises in the conditions of digital transformation. The authors show the main problems of constructing universal algorithms for making managerial decisions. Each stage of the algorithm is described in detail. Methodological recommendations are given for their passage through the stages of the algorithm for making managerial decisions in a digital enterprise.

2357-1330 © 2020 Published by European Publisher.

Keywords: Solution, technology, algorithm, management, enterprise, digital technologies



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1. Introduction

Today, one of the most relevant areas of modern science is the development of information technologies that underlie simulation and computational experiments in relation to the activities of industrial enterprises. At the same time, industrial production currently closes the rating of digital maturity of economic sectors (Danubianu, 2017).

In such conditions, there is a need to implement digital enterprise technology and develop effective tools for making optimal management decisions for business leaders. Such a tool can be economic simulators that allow you to accurately model trends in the development of the economy and the behavior of the company's stakeholders in various scenarios (Savevska, 2014).

2. Problem Statement

The scientific literature presents a variety of different algorithms and models for making managerial decisions in a given situation. However, there is no universal algorithm that can always be applied, regardless of what kind of problem the organization is facing, what caused it, what factors influence it, whether they are manageable, and so on.

Digital enterprise 4.0 technology assumes a special structure of the business model, in which information technology blurs the usual boundaries between markets, which in turn affects the process of making managerial decisions (Lawson, 2006).

We will not take into account any simple situations that occur constantly in any company, because they do not require any special algorithm to resolve. In such cases, it is enough to simply analyze the problem situation and make a decision that will result in the managed object being restored to the appropriate state.

Researchers define digital transformation as a process that is initiated and occurs under the influence of external factors, among which the main one is a positive customer experience. Partners and customers of the company today have a high level of expectations for access to information about the company's work, services and products. This level of user experience can only be achieved by using technologies that can aggregate and process data and then provide it to customers and partners. It is the positive customer experience that allows companies not only to stay on the market, but also to increase their presence. Achieving these results is closely related to improving operational efficiency, which is achieved in the process of digital transformation.

Digital enterprise opens up opportunities for new operating models and business processes, connected product platforms, Analytics, and teamwork to increase productivity.

While researching various scientific literature, we are faced with the problem of identifying what actually begins the process of making managerial decisions in a digital enterprise, which is the first stage of this algorithm. Most authors, such as M.M. Maksimov, V.A. Sozinov, A.D. Chernyavsky, and others, agree that the first necessary action is to identify and analyze the problem situation. Others believe that the whole process should start with setting goals and objectives. Proponents of this approach are F. Young, Bolshov A.V. If we consider the subsequent stages, it also becomes obvious that some experts have some stages of making a management decision ahead of them, while others have others. In other

words, there is clearly a problem with ranking the algorithm stages. Indeed, it is sometimes very difficult to build a strictly deterministic series of stages of decision-making in an organization, because too many different factors affect its activities (Lawson, 2006). The author's approach is not to build an algorithm for successive stages and procedures of the decision-making process, but to combine them into a certain sequential chain of blocks with feedback.

3. Research Questions

We have identified 3 main blocks that make up the decision-making algorithm for a digital enterprise. Let's look at them in detail.

The first block of the management decision-making process in a digital enterprise consists of the following stages (fig. 1):

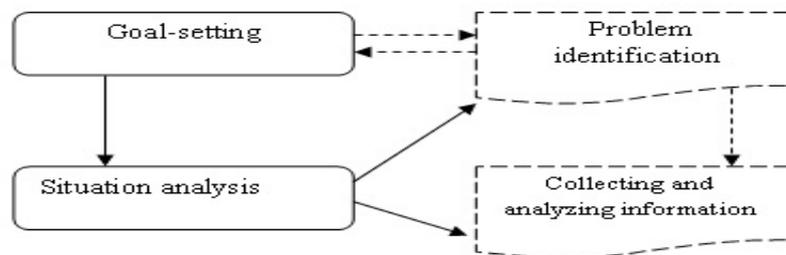


Figure 1. The first block of the decision-making process

It should be noted that many authors either do not distinguish goal setting as a separate stage, or they do not have this operation in their algorithm at all. In our opinion, setting a goal is important, because if there is no goal, then there will be nothing to compare the results achieved, it will be impossible to determine the effectiveness of the decision made, its adequacy. In addition, the absence of this stage violates the entire logic of the process. It turns out that we are doing some work, but we do not know why, what result we want to achieve, or whether this work is necessary at all. In this regard, the goal setting stage in our algorithm has one of the most important values.

In our opinion, it is the analysis of the situation that is the most voluminous in the decision-making process. A correctly defined problem already contains half the solution. At this stage, it will be necessary to classify, select or develop the most appropriate method of solving it, and check the occurrence of such a problem in the past.

Taking into account the time constraints, all the information necessary to solve the existing problem situation should be collected and analyzed. If the problem requires an immediate solution, this operation should be performed as soon as possible. It is not necessary to search for the best solution for a long time, but it is better to focus on the first most suitable, i.e. the one that will be less risky and costly. However, there are also situations when you should spend more time searching and analyzing the necessary information in order to subsequently get the highest quality and adequate solution, the effectiveness of which will cover all possible risks and costs.

We note that the problem identification operation sometimes falls out of the decision-making process. This is due to the fact that there are situations in the organization when the need to make a

decision is caused not by any problem, but by the desire of management to improve the company's activities or its part. In such cases, after setting a goal, you should immediately start collecting and analyzing the necessary information. In other words, the problem analysis stage becomes essentially one of its own sectors (Collecting and analyzing the necessary information).

The main distinctive feature or even specificity of this block is that the goal setting stage and the problem identification operation are almost parallel and very closely intertwined. In practice, in most cases, it is difficult to determine what is being done first: a goal is being set or a problem is being identified. In a situation where we want to make an innovative decision, the main goal is usually set initially, but then there is an intertwining: during the identification of the problem, secondary and intermediate goals appear. If we are talking about a situation where there is a deviation from the normal process of the company's activity (for example, a sharp drop in demand for a product), then first there is an analysis of the situation, and then setting goals.

The second block of the decision-making process is shown in figure 2.

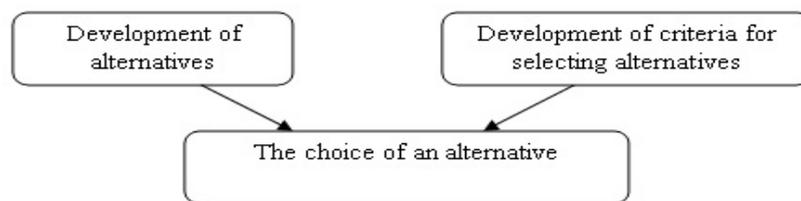


Figure 2. The second block of the decision-making process

The study of extensive theoretical and practical material has shown that most authors put the stage of development of alternatives after the stage of development of selection criteria, and only some recommend carrying them out in parallel. In our opinion, these stages should really be carried out independently of each other. First, it contributes to the generation of more alternatives. Second, when evaluating the alternatives themselves, any of the options that are considered insignificant and unrealistic or inadequate may receive logical and reasonable support because the factors that contribute to its implementation may not have been taken into account at the stage of developing the selection criteria.

In connection with the above, the stage of determining the selection criteria should be carried out in parallel with the stage of developing alternatives. In addition, in the case of removal from the criteria, it is possible to generate alternatives that can't be applied at the moment, but in the future their implementation will not only be possible and carried out in a short time (you do not need to go through the entire decision-making algorithm again), but will also bring profit to the organization. The criteria themselves can be varied and depend on the specific problem that needs to be resolved. However, there are some that we recommend always using, regardless of the situation:

- Cost-effectiveness;
- Probability of successful implementation;
- Financial cost;
- The cost of time;
- Human resources;
- The degree of achievement of the goal.

At the same stage, in our opinion, you should choose a backup alternative, which may be necessary in the event of the main one's failure. This will greatly save a lot of resources of the organization and minimize possible losses if the decision made in the course of its execution shows its inadequacy, or inferiority in achieving the goals set, since its choice is always guided only by the forecast of possible events, and not by an accurate knowledge of the consequences of the choice.

Promising ideas, as well as ideas that are currently impossible to implement or are in question, should be placed in a so-called Bank, so that later, when a favorable moment arrives, they can be implemented and implemented as quickly as possible. If such a repository of knowledge does not exist in the company, then it must be organized, i.e. however, based on the domestic experience, many of our companies do not pay due attention to not only good, but also amazing ideas that in the near future can bring both solid profits and leadership in a certain field of activity. This Bank should be constantly monitored so as not to miss the moment when the idea and all the conditions for its implementation are already ripe and it needs to be removed from the archive.

After choosing an alternative, the decision-making process does not end its functioning, because the choice itself does not bring any dividends to the organization. The real value and benefits of a solution can only be understood and evaluated by the company after it has been implemented. Thus, we need the third block of the decision-making process (Fig. 3).



Figure 3. The third block of the decision-making process

At the implementation stage, the selected alternative is implemented. It is necessary to clearly distribute all the necessary activities and tasks among the performers. You should also assign responsible employees to perform each of the tasks. Each participant in the decision implementation process should feel their personal responsibility and the importance of participating in this stage. For more successful and productive implementation of this stage, a certain system of employee motivation should be developed. This system is individual for each organization, because it should take into account the motivating factors of specific employees (or rather specific people, since any employee of the organization is primarily a person with their own specific individual needs, values and personal characteristics).

Parallel to the stage of implementation of the chosen alternative is the stage of monitoring and evaluating the results of the decision. This is where the decision results are measured and evaluated, and actual and planned indicators are compared. This stage, in our opinion, should go exactly in parallel, and not after the implementation stage of the decision, because this makes it possible to instantly correct deviations from the planned action plan. In addition, at an early stage, the inadequacy and inconsistency of the adopted alternative may be revealed, and the possibility of reconsidering the decision with minimal losses for the organization may be revealed. At the control stage, criteria for evaluating results should be developed. The main actors in this stage are the employees who are responsible for implementing the decision. They must constantly analyze the results of implementing the chosen alternative, monitor the correct execution of tasks, and respond in time to all deviations from the planned action plan.

4. Purpose of the Study

The main goal of the research is to develop an algorithm for making intelligent management decisions for a digital enterprise of technology 4.0.

To achieve this goal the authors have solved the following tasks:

- to consider the process of making management decisions in a digital enterprise;
- to describe the stages of making an intelligent management decision, highlight the main elements.
- to propose an algorithm for making managerial decisions in a digital enterprise.
- to reveal the conceptual model of management decision-making in a digital enterprise under conditions of uncertainty.

5. Research Methods

The methods of system dynamics, Data Mining, and chaos theory are used to predict trends in macro-environment factors and predict crises. The forecast is made based on statistical data received by the monitoring system using phase analysis (Vasin & Morozov, 2015), Box - Jenkins models, taking into account the forecast horizon. The forecast horizon is determined using the Lyapunov exponent. The forecast of the beginning of crises is carried out using phase portraits (Zagrebnev, 2017).

The analysis of the internal environment of the enterprise is carried out on the basis of the system of balanced indicators and the theory of chaos (Drozdov et al., 2018).

6. Findings

Thus, the developed algorithm for making managerial decisions in the organization is shown in figure 4.

By means of feedback, all information about the implementation of the decision, its results are sent to the Manager, who in turn can also make any adjustments and recommendations by means of feedback. The success of the feedback process has a significant impact on the implementation of the decision in the organization.

Feedback is difficult to distinguish in any separate stage of the decision-making algorithm in the organization, because it functions both in separate stages and between them throughout almost the entire process. In our proposed algorithm, it is placed separately in the place where its value is greatest and it should be given more attention.

To develop optimal management decisions, it is necessary to identify patterns of development of the situation, predict the onset of crises and form strategic rules according to which decisions are made.

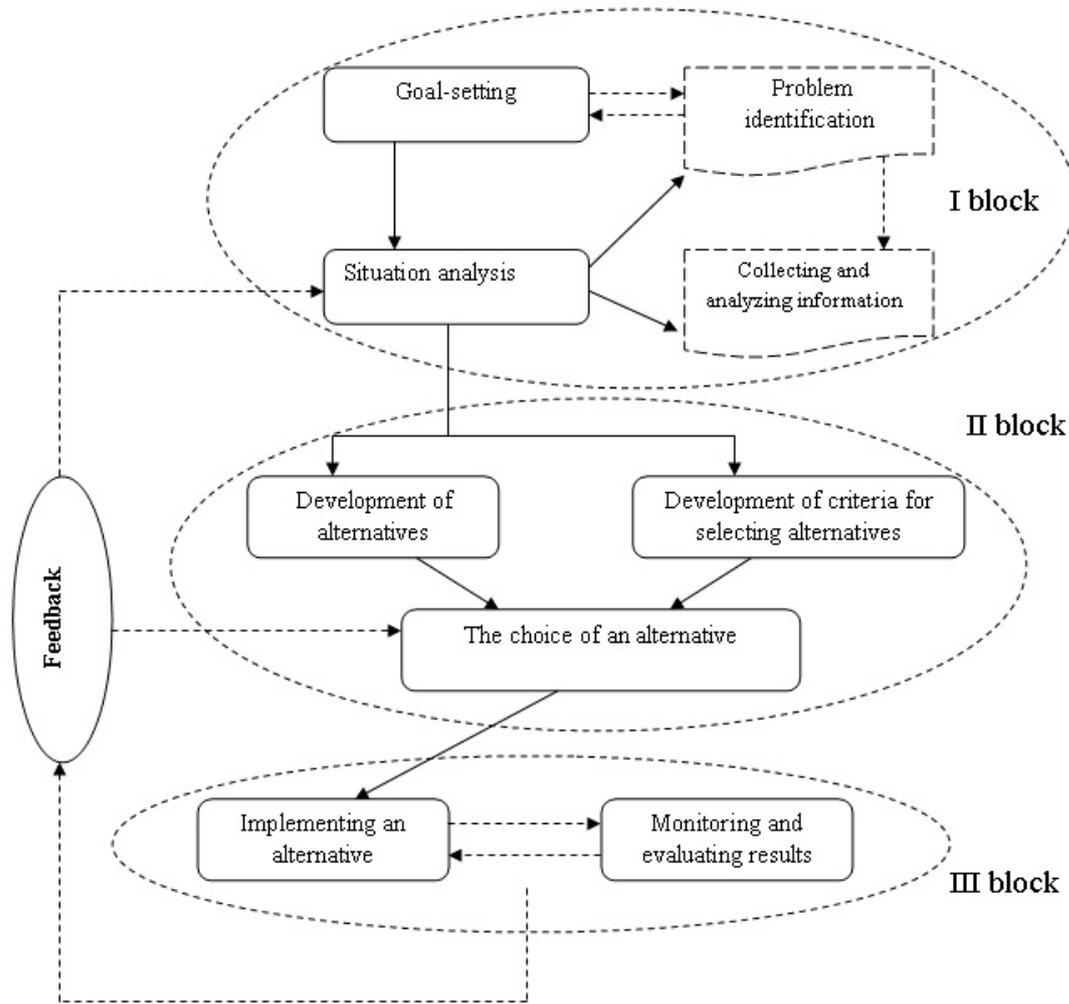


Figure 4. Algorithm for making management decisions in a digital enterprise

To identify patterns of situation development and forecast crises, the external and internal environment of the enterprise is analyzed. The external environment of an industrial enterprise is divided into two components:

- macro environment;
- microenvironment.

The result of the analysis of the external and internal environment is the formation of a vision, setting strategic goals, determining the planning horizon (short-term, medium-term, long-term). Goals are set using GAP analysis and the confidence interval of the forecast (Lawson, 2006).

At the next stage, significant factors affecting the company's activity are identified using regression analysis, neural and hybrid networks, and a balanced scorecard system (Tagiltseva et al., 2017).

The scenario method is used to remove uncertainty. Therefore, taking into account the scenario approach, the following groups of factors affect the activity of the enterprise:

- General (the values of these factors change over time, but do not change when scenarios change);
- scenario (the values of these factors change not only over time, but also in scenarios);

- managed (these are factors that influence the process of achieving goals).

These factors can affect not only the characteristics of the process (strategic goals), but also indirectly, by influencing other factors. The structure of interaction of factors with each other and with strategic goals is set by means of a conceptual model and then the algorithm for making management decisions is transformed (Fig. 5).

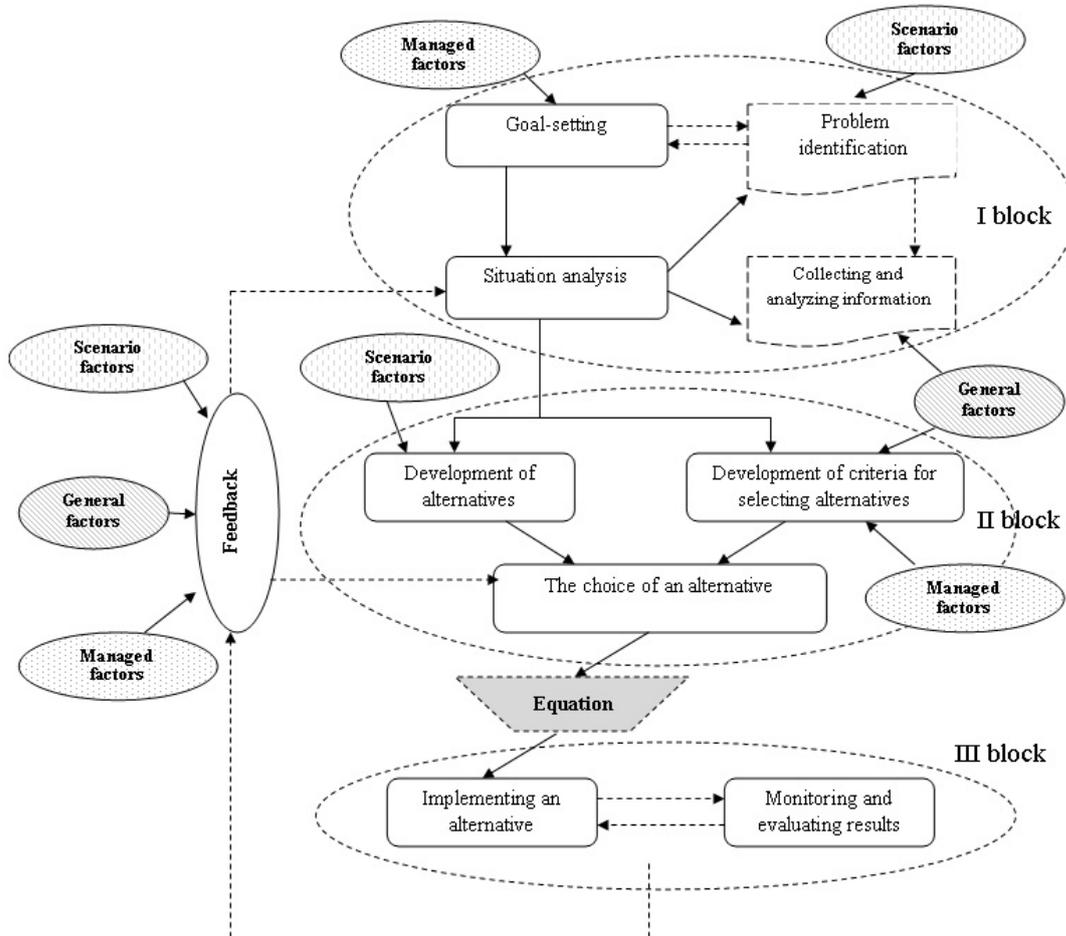


Figure 5. Algorithm for making management decisions in a digital enterprise in conditions of uncertainty

Structural, General, and managed factors do not have input relationships. Input and output relationships show the interaction of factors and strategic goals with each other. If a factor has input and output connections, it turns into a structural one that connects factors of different layers (Drozdov et al., 2018). The influence of factors is described using regression equations, neural networks, or hybrid networks. To develop strategic rules, we use strategic scenarios that set the dynamics of changes in scenario factors. For each scenario, the values of the managed factor are determined at each time, taking into account the specified restrictions. There may be several such values for each time point. These values of controlled factors form the basis for the development of strategic management decisions.

7. Conclusion

The proposed algorithm is universal and suitable for making intelligent management decisions. It will allow managers of industrial enterprises to ensure the transition to digital transformation, predict with sufficient accuracy the trends in the development of the situation, anticipate crises and determine the key directions of enterprise development, and develop optimal strategic plans.

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