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MODELING TACTICS CONTROL IN AUTOMATED CONTROL SYSTEMS

In this paper, the example of the production logistics enterprise system, analyzed the process of management of the facility management and control tactics formulated for the management subsystem that achieves optimal results in compliance with the stable state of the facility management.

Keywords: automated control system; facility of management; managing subsystem; material flow; the estimated function; integrated estimate; the state of an imminent crisis; tactics stable optimality.

Introduction

The research of the life cycle of automated control systems (ACS) of technological processes in complex organizational-technical objects is important scientific and practical direction to which it is connected, on the one hand, using the results of basic research in areas such as Cybernetics, operations research, optimal decisions theory and mathematical methods in Economics, on the other hand, it is the practice of real economic activity with the use of financial-economic analysis of the different stages of the life cycle of the ASC. As organizational and technical research object is considered in the article production logistics system of the enterprise.

The main task of production of the logistic system of the enterprise is stable and timely provision of production process, as well as interaction with external logistics - absorbing incoming material flow generated by the procurement logistics, and the output of material flow for distribution logistics.

Analysis of the last researches and publications

Research in the field of production logistics there are several ways using different approaches. One of them is an economic approach, for example [1], the analysis of stability of the enterprise. Another approach is based on the analysis of material flows in the enterprise and impact of production logistics on the overall condition of the enterprise, for example [2]. Generalizing on the research and systematic presentation of production logistics can be found in textbooks [3] and [4].

Research objective

The relevance of research in the chosen direction is unmistakable and confirmed with a wide range of publications, professional and scientific periodicals, monographs, tutorials and textbooks.

From the point of view of economic science models of production logistics belong to the microeconomic models. They have a goal to find the optimum organization of production and logistics, at the current state of organization of production at the enterprise, to find vulnerable elements of logistics enterprises in case of unfavorable factors, to determine the boundaries of adaptability of the company's logistics system. In modern conditions of managing production logistics system of the enterprise is a complex combination of technical and human resources which constitute a single body, the existence of which is ensured by constant circulation of information.

The purpose of this study is the analysis of the system of industrial logistics of the enterprise as a complex of organizational-technical systems with the definition of the optimal tactics for automated production management system logistic system of the enterprise.

Modeling tactics of the automated systems of management of processes of production logistics

We will consider production and logistic system of the enterprise L as a set of two components O - the object of control and M - management subsystems:

$$L = <O, M>, \qquad (1)$$

located in the environment. For industrial logistic system of the company in this environment is the enterprise (Fig. 1).

Figure 1. Structural scheme of production logistics and its environment

Condition of object of management is not constant, it changes under the influence of time and under the influence of the environment. Also the management system influences the state of the object management perform certain administrative actions. In the theory of decision making the entire set of management actions that can be performed by the managing subsystem called alternatives, and an action or set of actions taken to execution called solution [5].

Let us introduce A the set of all actions available to the management subsystem, through Θ denote the set of all states of the environment, and through S many states of the object management. We introduce the following limitation on the set A, Θ end S, and we will consider them scenami. This limitation is a necessary measure in the development of computerized models and is caused by the nature of computer equipment.

Definition 1. If there is a display that each tuple $\langle a, \theta \rangle$, what belongs to the set of a Cartesian product of sets A end Θ ($\langle a, \theta \rangle \in A \times \Theta$) corresponds to only one element $s \in S$, i.e.

$$R : A \times \Theta \mapsto S,$$

then object management O of logistics systems L we will call unequivocally managed control subsystem M of logistics systems L.

In theory, decision making, much attention is paid to finding the optimal solution. To determine the optimal solution, you must enter the opportunity to compare the various States of the object management O. If two different states $s_i, s_j \in S$ control object O, that will be received for the current state of the environment and the control object in the result of application of various solutions $a_i, a_j \in A$, you can say that one of these States is the best for the other, the best will be called the solution that under the current conditions may result in the best condition possible control object.

Suppose that to each state $s_i \in S$ of control object O there is a possibility to match the number $\xi_i = \xi(s_i)$, such that the conditions "s_i better s_j" follows that $\xi(s_i) > \xi(s_j)$. In this case $\xi(s)$ є the evaluation function that allows you to measure the state of a control object O, and the principle on which is constructed the function "the better the condition of the control object, the greater the value estimator".

Using the estimated function $\xi(s)$ consider the example of the decision (example 1). Let the object of control O is in a state s_0 in time t_0. For this object state management and environmental protection are three alternatives $a_1^{(1)}, a_1^{(2)}$ та $a_1^{(3)}$, which brings the object of management in state $s_1^{(1)}, s_1^{(2)}$ та $s_1^{(3)}$ respectively (see Fig. 2).
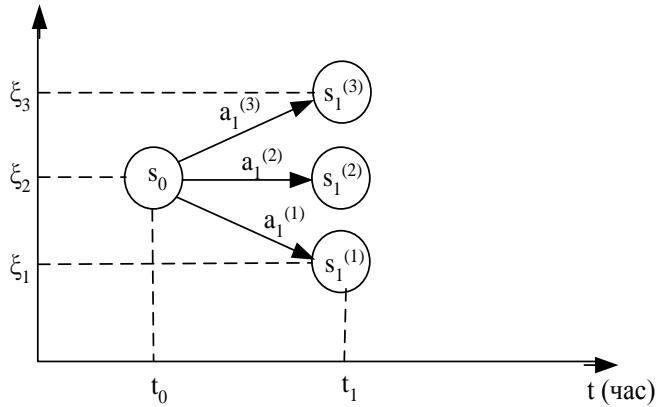

Figure 2. Example 1. The consequences of decision making $a_1^{(1)}, a_1^{(2)}$ end $a_1^{(3)}$ for object management O

On Fig. 2 for each of the states $s_1^{(1)}, s_1^{(2)}$ end $s_1^{(3)}$ shows the corresponding value estimator $\xi(s)$. In the given example, the alternative $a_1^{(3)}$ is advantageous because translates the object of management in the state $s_1^{(3)}$, which matter evaluation function ξ_3 more all possible $\{\xi_1, \xi_2, \xi_3\}$.

Consider the example 2, which includes example 1 as an integral part. Even if, as in example 1, the object management O is in a state s_0 in time t_0. We know the state of the environment θ_0 end θ_1 in moments t_0 end t_1 according to. As in example 1 at the moment t_0 there are three alternatives $a_1^{(1)}, a_1^{(2)}$ end $a_1^{(3)}$, which brings the object of management in state $s_1^{(1)}, s_1^{(2)}$ та $s_1^{(3)}$ accordingly, also known alternatives for each object state control $s_1^{(1)}, s_1^{(2)}$ end $s_1^{(3)}$ for state θ_1 for state, which will be available at the moment t_1. On Fig. 3 depicts this situation.

In the moment t_2 a control object can be in one of the states $s_2^{(1)} \div s_2^{(5)}$. On Fig. 3 these States are in accordance with the values of their evaluation function and ways of achieving these States. For this example, the values of the evaluation function of the States of a control object is chosen so that is the ratio $\xi(s_1^{(2)}) + \xi(s_2^{(5)}) > \xi(s_1^{(3)}) + \xi(s_2^{(2)})$. The purpose is to demonstrate the fact that the choice of the best alternative in a certain moment of time (in this example, the choice of alternatives $a_1^{(3)}$ in the moment t_0) does not guarantee achieve the best overall result.
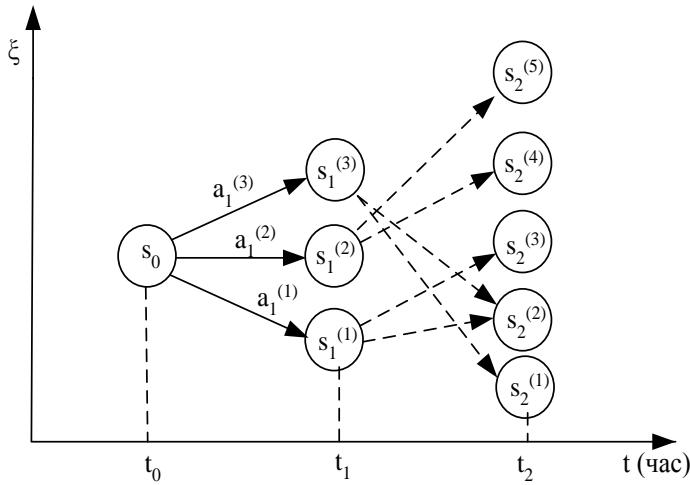
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Figure 3. Example 2. The consequences of decision making to control object at times t_1 and t_2

We introduce the parameter $\rho(t)$ scales the evaluation function, which allows you to set for the owner of the problem, the importance of the control object in one state or another. For example, in normal setting the weight parameter $\rho(t)$ the same for any moment of time. But in the life cycle of the ASC can occur periods, when the status of the control object becomes "good as gold"or Vice versa is object of management for the owner of the problem moves to "second roles".

Introduce integrated assessment of facility management for a period of time $t_1 \div t_n$:

$$\Xi = \sum_{i=1}^{n} \rho_i \xi_i, \qquad (2)$$

where $i = \overline{1,n}$ the index of the point in time that is considered, $\rho_i = \rho(t_i)$ - the weight parameter of the evaluation function at the moment t_i, ξ_i - the estimated value of the function object state control in the moment t_i.

Now we can find the optimal period of time $t_1 \div t_n$, a number of control actions (decisions) on the object of management, such as that leads to the maximum value of the integral assessment of the condition of the object of management (2):

$$\Xi(\alpha) \to \max, \qquad (3)$$

where α - this number n with consistently selected alternatives from many A, i.e. $\alpha \in \underbrace{A \times A \times \ldots \times A}_{n}$.

The upper boundary of the computational complexity of the search for the optimal sequence of length n steps can be estimated as $\|A\|^n$ - the cardinality of the set of alternatives d grade n.

Розглянемо область значень оціночної функції. Дуже часто такі функції задають як нормовані в діапазоні $[0,1]$. So a value of 0.75 will meet such a concept as "satisfied with the condition of object of management is 75%and the value 1 is "satisfied hundred"or "better than nothing". In our case be set to the evaluation function is therefore inappropriate. The evaluation function needs for critical States of a control object, bordering the destruction of the object of management or of the entire system, to give such values, which cross out the significant achievements in the past. Thus we come to the need to specify the range of values of the evaluation function in the range $[-\infty, \infty]$. Now for the crisis object state management and state, which it is desirable to avoid, is the evaluation function can be set as a large (by module) negative number. This will allow to avoid some of the decisions (3)that leads to the crisis state of the control object.

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Consider now the behavior of the environment. Until then, the behavior of the environment was seen as the predestinated, that is deterministic. Consider the situation when only known probabilities of different environmental health in the next moment, that is time for each of the possible States of the environment $\theta_j \in \Theta$ known for their probabilities $p^{(i+1)}(\theta_j)$ in a moment of time t_{i+1}. It is clear that for any point t_i the following rule is

$$\sum_{j=1}^{m} p^{(i+1)}(\theta_j) = 1,$$

where m – cardinality Θ (the number of States, which may be the environment), end i – the index point in time process, which is being considered. Analyzing how it may influence the state of the environment state of the object control (Fig. 1). Proceeding from the known thesis that "everything in this world depends on all influence and control object on the environment categorised with the help of introduction of impact criterion K two grades of "strong influence" and "low impact":

$$K = \{\text{stronginfluence, low impact}\}. \tag{4}$$

An example of a control object with the assessment of "strong influence", in Economics, may be a monopolist, whose actions can affect their environment - the market of the product concerned. But, the small manufacturer on the same product market will be classified by the value of "low impact". Usually the grading scale for such criteria is much more diverse. And the proposed schedule (4) is sufficient to build the following behavior of the environment.

For the strong influence of this would be:

$$\theta^{(i+1)} = f(\theta^{(i)}, s^{(i)}, a^{(i)}), \tag{5}$$

where $\theta^{(i+1)}$ end $\theta^{(i)}$ – the state of the environment in times t_{i+1} end t_i, $s^{(i)}$ – the state of the object management in time t_i, $a^{(i)}$ - the decision was made at the time t_i, $f()$ – probabilistic function of its arguments.

For weak effects:

$$\theta^{(i+1)} = f(\theta^{(i)}),$$

where $\theta^{(i+1)}$, $\theta^{(i)}$ end $f()$ have the same meaning as in (5).

If the object management meets the definition of a centrally managed (see definition 1), (5) record thus:

$$\theta^{(i+1)} = f(\theta^{(i)}, s^{(i+1)}),$$

where $s^{(i+1)}$ – the state of the object control points in time t_{i+1}, all other factors have the same meaning as in (5).

Enter $\xi_{\text{криз}}$ – this is an estimator that is the upper limit for crisis management object. On Fig. 4 shows such a state s_i control object that any of the possible alternatives leads to transfer of control object in the crisis condition. That is, the state s_i is that not allows to avoid crisis.

Definition 2. The state of the object management when any decision leads to crisis management object is called a state of imminent crisis.

According to the distribution, at the strategic, tactical and operational possible to formulate tactics ("tactics stable optimality) of a management subsystem M (1):
- avoid contact with the object of control in a state of imminent crisis;
- to maximize the integral assessment of the state of the object management.
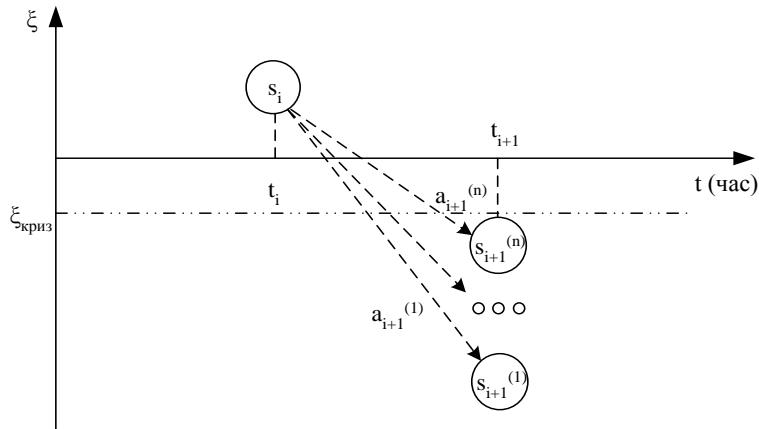
Figure 4. The pre-crisis state of the object management O

For the realization of the above tactics necessary to calculate the possible condition of the object of control and condition of the environment on the maximum number of moves (time) and choose at every step of that alternative that best meets the requirements of the above tactics.

If you compare the computational complexity of the above tactics for systems according to the criterion of influence (4), it will be less for systems with a "strong influence" for the same time interval, than for systems with weak influence".

Conclusions

During the research, production and logistics system of the company was presented as a set of two components O - object management and M - management subsystem (1), which operates in the environment (Fig.1). Inserted a definition of an object is uniquely managed by management subsystem. On the basis of the evaluation function and setting the weight of the evaluation function was introduced integrated assessment (2) state control object for the certain period of time. Also inserted a definition of the status of an imminent crisis for the control object.

On the basis of input definitions and performed analysis formed the tactics of optimal control ("tactics of the optimal stability") for ASC industrial logistic system of the enterprise. The proposed tactics aimed at achieving sustainable results.

Further development of the research, the authors see in designing software that automates support of decision making in the logistics system of the company according to the tactics of the optimal stability.

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