Static and dynamic management models production at the entity

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Abstract. Static and dynamic economic-mathematical models for the solution of tasks of information support and optimization of integrated management of engineering procedures at the entity are described. Within these models algorithms of the solution of static and dynamic tasks of information support and complex optimization of management of engineering procedures at the entity are proposed.

Keywords: economic-mathematical model, management of technological processes, algorithms of the solution of static and dynamic tasks.

1. Static model of optimization of integrated management of engineering procedures at the entity

For formalization of this task we will enter the following designations:

n – total of types of production;

$Q(t) = (Q_1(t), Q_2(t), \dots, Q_n(t)) \in R^n$ – a vector of amounts of a remaining balance of products which are stored in warehouses of the entity in the period of time of t ($t \in \overline{0, T-1}$) which each kth the coordinate of $Q_k(t)$ has a value of amount of products kth of a type ($k \in \overline{1, n}$);

$\langle z(t), \overline{Q}(t) \rangle_n$ – value of all amount of expenses for storage of finished goods in warehouses of the entity in the period of time of t ($t \in \overline{0, T-1}$) in the amount described by a vector of $Q(t)$ in case of a vector of costs of $z(t) = \{z_1(t), z_2(t), \dots, z_n(t)\} \in R^n$ which each kth the coordinate of $z_k(t)$ has an amount of the costs of storage of a unit of production of kth of a type of ($k \in \overline{1, n}$); hereinafter R^k – k-dimensional vector space; for any vectors of a, $b \in R^k$ expression of $\langle a_k, b_k \rangle$ is their scalar product; $\overline{1, n} = \{1, 2, \dots, n\}$;

$d^{(i)}(t) = \left\{d_1^{(i_1)}(t), d_2^{(i_2)}(t), \dots, d_n^{(i_n)}(t)\right\} \in R^n$ – a vector of all costs of the entity for production of single amount of products when using i-go of a technological method with a vector of intensity of $u^{(i)}(t) = \left\{u_1^{(i_1)}(t), u_2^{(i_2)}(t), \dots, u_n^{(i_n)}(t)\right\} \in R^n$ in the period of time of t ($t \in \overline{0, T-1}$) where $i = \{i_1, i_2, \dots, i_n\}$ is a set of integer indexes determining ith technology; for each $k \in \overline{1, n}$: $i_k \in I_k = \{1, 2, \dots, i_k^*\}$, i_k^* is amount of admissible technologies for production of kth of a type; $u_k^{(i_k)}(t) \in \{0; 1\}$ is value of intensity of the production technology of products kth of a type answering to the $i_k \in I_k$ index and $u_k^{(i_k)}(t) = 0$ value in case this technology isn't used also by $u_k^{(i_k)}(t) = 1$ in a case when it is used; $d_k^{(i_k)}(t)$ is amount of unit costs of kth of a type when using $i_k \in I_k$ technology;

$Q^{(p)}(t) = \left(Q_1^{(p)}(t), Q_2^{(p)}(t), \dots, Q_n^{(p)}(t)\right) \in R^n$ – a vector of planned production volumes of all products of the entity in the period of time of t ($t \in \overline{0, T-1}$);

$\langle c(t), Q^{(p)}(t) \rangle_n$ – value of planned amount of the income from sale of all products of the entity in the period of time of t ($t \in \overline{0, T-1}$) in case of production in the planned amount determined by a vector of $Q^{(p)}(t) = \left(Q_1^{(p)}(t), Q_2^{(p)}(t), \dots, Q_n^{(p)}(t)\right)$ in case of a vector of prices for products of the entity of $c(t)=\{c_1(t),c_2(t),\dots,c_n(t)\}\in R^n$ in which for each $k\in\overline{1,n}$ value of coordinate $c_k(t)$ is the predicted unit price of products of kth of a type for the same period of time;

$Z_i^{(p)}(t)=\left\{Q_1^{(p)}(t)d_1^{(i_1)}(t),Q_2^{(p)}d_2^{(i_2)}(t),\dots,Q_n^{(p)}d_n^{(i_n)}(t)\right\}\in R^n$ – a vector of amount of all costs of the entity when using ith of the technological method determined by a vector of $u^{(i)}(t)=\left\{u_1^{(i_1)}(t),u_2^{(i_2)}(t),\dots,u_n^{(i_n)}(t)\right\}\in R^n$ for production of planned amount of products $Q^{(p)}(t)=\left(Q_1^{(p)}(t),Q_2^{(p)}(t),\dots,Q_n^{(p)}(t)\right)$ in the period of time of t $(t\in\overline{0,T-1})$;

$\left\langle Z_i^{(p)}(t),u^{(i)}(t)\right\rangle_n$ – amount of all costs of the entity when using ith of the technological method determined by a vector of $u^{(i)}(t)=\left\{u_1^{(i_1)}(t),u_2^{(i_2)}(t),\dots,u_n^{(i_n)}(t)\right\}$ in case of a vector of amount of all costs of the entity of $Z_i^{(p)}(t)$ in the period of time of t $(t\in\overline{0,T-1})$.

Then the total amount of profit on production and sales of products of the entity in the period of time of $\overline{t,t+1}$ $(t\in\overline{0,T-1})$ in case of $Q(t)=\left(Q_1(t),Q_2(t),\dots,Q_n(t)\right)$ fixed a vector – amounts of a remaining balance of products in stock, a vector of $Q^{(p)}(t)=\left(Q_1^{(p)}(t),Q_2^{(p)}(t),\dots,Q_n^{(p)}(t)\right)$ – planned production volumes of all products of the entity for this period of time, the vector of $u^{(i)}(t)=\left\{d_1^{(i_1)}(t),u_2^{(i_2)}(t),\dots,u_n^{(i_n)}(t)\right\}$ determining $i=\{i_1,i_2,\dots,i_n\}$th a technological method of production of all products at the entity, a vector of $c(t)=\{c_1(t),c_2(t),\dots,c_n(t)\}$ – the predicted prices, a vector of $z(t)=\{z_1(t),z_2(t),\dots,z_n(t)\}$ – amounts of all warehouse costs of the entity, vectors of $d^{(i)}(t)=\left\{d_1^{(i_1)}(t),d_2^{(i_2)}(t),\dots,d_n^{(i_n)}(t)\right\}\in R^n$ – all costs of the entity for production of single amount of products and $Z_i^{(p)}(t)=\left\{Q_1^{(p)}(t)d_1^{(i_1)}(t),Q_2^{(p)}d_2^{(i_2)}(t),\dots,Q_n^{(p)}d_n^{(i_n)}(t)\right\}$ – amounts of all costs of the entity when using ith of a technological method for production of planned amount of products, it is possible to determine as value of the following linear functionality:

$$\Phi_{\overline{t,t+1}}\left(u^{(i)}(t)\right)=\left\langle c(t),Q^{(p)}(t)\right\rangle_n-\langle z(t),Q(t)\rangle_n-\left\langle Z_i^{(p)}(t),u^{(i)}(t)\right\rangle_n, \tag{1}$$

where $i=\{i_1,i_2,\dots,i_n\}\in I=\left\{i: i=\{i_1,i_2,\dots,i_n\},\forall\, k\in\overline{1,n}\,,i_k\in I_k\right\}$ and all components of vectors $Q^{(p)}(t)$, $Q(t)$, $Z_i^{(p)}(t)$, $u^{(i)}(t)$ also are integer.

At the same time for all $k\in\overline{1,n}$ and $t\in\overline{0,T-1}$ inequalities shall be carried out:

$$Q_k(t)\geq 0,\quad Q_k^{(p)}(t)\geq 0, \tag{2}$$

and values of vectors $u^{(i)}(t)$ which determine intensity of use of ith of a technological method of production at the entity shall get out of some admissible $U^*(t)\subset R^n$ area, i.e. satisfy to the set restriction of:

$$u^{(i)}(t)=\left\{u_1^{(i_1)}(t),u_2^{(i_2)}(t),\dots,u_n^{(i_n)}(t)\right\}\in U^*(t), \tag{3}$$

where the set of $U^*(t)$ is determined as follows:

$$U^*(t)=\left\{u^{(i)}(t): u^{(i)}(t)=\left\{u_1^{(i_1)}(t),u_2^{(i_2)}(t),\dots,u_n^{(i_n)}(t)\right\},\ \forall\, k\in\overline{1,n},\quad u_k^{(i_k)}\in\{0;1\}\right\}. \tag{4}$$

The solution of a task 1 [1-3] – optimizations of integrated management of engineering procedures at the entity (in case of the set planned production volumes, products remaining balance in stock, all storage costs of products, all technological costs and the predicted prices for products) will consist in finding of an optimum vector of $u^{(i^{(e)})}(t) \in U^*(t)$ (optimum intensity of technological methods of production) in case of which value of total amount of profit on production and sales of products of the entity in the period of time of $\overline{t, t+1}$ calculated according to Eq. (1) will be maximum (due to minimization of all expenses of the entity), i.e. for a vector of $u^{(i^{(e)})}(t)$ the following condition of an optimality shall be satisfied:

$$\begin{aligned} \Phi_{\overline{t,t+1}}(u^{(i^{(e)})}(t)) &= \left\langle c(t), Q^{(p)}(t)\right\rangle_n - \langle z(t), Q(t)\rangle_n - \left\langle Z_i^{(p)}(t), u^{(i^{(e)})}(t)\right\rangle_n \\ &= \max_{i\in I} \max_{u^{(i)}(t\cdot)\in U^*(t)} \left\{\left\langle c(t), Q^{(p)}(t)\right\rangle_n - \langle z(t), Q(t)\rangle_n - \left\langle Z_i^{(p)}(t), u^{(i)}(t)\right\rangle_n\right\} \\ &= \left\langle c(t), Q^{(p)}(t)\right\rangle_n - \langle z(t), Q(t)\rangle_n - \min_{i\in I} \min_{u^{(i)}(t\cdot)\in U^*(t)} \left\langle Z_i^{(p)}(t), u^{(i)}(t)\right\rangle_n, \end{aligned} \tag{5}$$

in case of accomplishment of restrictions Eq. (2).

Let's note that the task 1 is a static problem of integer linear programming which solution can be found, for example, by means of the corresponding modification a simplex method for the solution of problems of linear integer programming or the directed search of admissible options.

Let's assume that based on a ratio Eq. (5) the following condition is satisfied:

$$U_*^{(e)}(t) = \left\{u^{(i^{(e)})}(t):\ u^{(i^{(e)})}(t) \in U^*(t),\ \Phi_{\overline{t,t+1}}\left(u^{(i^{(e)})}(t)\right) > 0\right\} \neq \emptyset, \tag{6}$$

i.e. there is a vector of $u^{(i^{(e)})}(t) = \left\{u_1^{\left(i_1^{(e)}\right)}(t), u_2^{\left(i_2^{(e)}\right)}(t), \ldots, u_n^{\left(i_n^{(e)}\right)}(t)\right\} \in U^*(t)$ determining intensity of use of $i^{(e)}$th a technological method of production at the entity in case of which implementation production is profitable.

Let's note that accomplishment of a ratio Eq. (6) is the generalized criterion of profitability of production at the entity in planned amount, rather existing engineering procedures, in case of a possibility of its implementation at the predicted prices.

Then based on the given formalization, the economic-mathematical model of a task of optimization of integrated management of engineering procedures at the entity is described by ratios Eqs. (1)-(5). Using this model, the algorithm of the solution of a task 1 is offered, the general scheme of which consists of implementation of the following main stages.

Algorithm 1.

Stage I. Formation of source data.

1.1. The vector of $Q(t) = (Q_1(t), Q_2(t), \ldots, Q_n(t)) \in R^n$ – a vector of amounts of all remaining balance of products in stock in the period of time of t ($t \in \overline{0, T-1}$) is formed.

1.2. The vector of $Q^{(p)}(t) = \left(Q_1^{(p)}(t), Q_2^{(p)}(t), \ldots, Q_n^{(p)}(t)\right) \in R^n$ – a vector of planned volumes of production of the entity in the period of time of t ($t \in \overline{0, T-1}$) is formed;

1.3. The vector of costs of $z(t) = \{z_1(t), z_2(t), \ldots, z_n(t)\} \in R^n$ which each kth the coordinate of $z_k(t)$ has unit costs of k-go of a type of ($k \in \overline{1, n}$) which is stored in stock in the period of time of t ($t \in \overline{0, T-1}$) is formed.

1.4. The vector of prices for products of the entity of $c(t) = \{c_1(t), c_2(t), \ldots, c_n(t)\} \in R^n$ in which for each $k \in \overline{1, n}$ value of coordinate $c_k(t)$ is the predicted unit price of products of kth of a type in the period of time of $\overline{t, t+1}$ is formed of results of marketing researches.

1.5. The admissible $U^*(t) \subset R^n$ area of all possible ith of the technological methods of production described by the corresponding vector of intensity of $u^{(i)}(t) = \left\{u_1^{(i_1)}(t), u_2^{(i_2)}(t), \ldots, u_n^{(i_n)}(t)\right\} \in U^*(t)$, where $i = \{i_1, i_2, \ldots, i_n\} \in I = \left\{i: i = \{i_1, i_2, \ldots, i_n\}, \forall\, k \in \overline{1, n}, i_k \in I_k\right\}$ is formed.

1.6. Are formed a vector of $d^{(i)}(t) = \left\{d_1^{(i_1)}(t), d_2^{(i_2)}(t), \dots, d_n^{(i_n)}(t)\right\} \in R^n$ – all costs of the entity for production of single amounts of products and on its basis – $Z_i^{(p)}(t) = \left\{Q_1^{(p)}(t)d_1^{(i_1)}(t), Q_2^{(p)}d_2^{(i_2)}(t), \dots, Q_n^{(p)}d_n^{(i_n)}(t)\right\} \in R^n$ – a vector of all costs of the entity when using ith of the technological method determined by a vector of $u^{(i)}(t) = \left\{u_1^{(i_1)}(t), u_2^{(i_2)}(t), \dots, u_n^{(i_n)}(t)\right\} \in U^*(t)$ for production of planned amount of products $Q^{(p)}(t) = \left(Q_1^{(p)}(t), Q_2^{(p)}(t), \dots, Q_n^{(p)}\ (t)\right)$ in the period of time of t $(t \in \overline{0, T-1})$.

Stage II. Creation of criterion function.

2.1. According to a Eq. (1), the linear functionality of $\Phi_{\overline{t,t+1}}$ which each value $\Phi_{\overline{t,t+1}}(u^{(i)}(t))$ amount of profit on production and sales of products of the entity in the period of time of $\overline{t, t+1}$ $(t \in \overline{0, T-1})$ in case of the fixed vector of $Q(t) = \left(Q_1(t), Q_2(t), \dots, Q_n\ (t)\right)$ is – amounts of all products in stock, a vector of $Q^{(p)}(t) = \left(Q_1^{(p)}(t), Q_2^{(p)}(t), \dots, Q_n^{(p)}\ (t)\right)$ – planned production volumes of all products of the entity for this period of time, the vector of $u^{(i)}(t) = \left\{u_1^{(i_1)}(t), u_2^{(i_2)}(t), \dots, u_n^{(i_n)}(t)\right\}$ determining $i = \{i_1, i_2, \dots, i_n\}$th a technological method of production at the entity, a vector of $c(t) = \{c_1(t), c_2(t), \dots, c_n(t)\}$ – the predicted prices, a vector of $z(t) = \{z_1(t), z_2(t), \dots, z_n(t)\}$ – all warehouse costs and a vector of $Z_i^{(p)}(t) = \left\{Q_1^{(p)}(t)d_1^{(i_1)}(t), Q_2^{(p)}d_2^{(i_2)}(t), \dots, Q_n^{(p)}d_n^{(i_n)}(t)\right\}$ – all costs of the entity is formed when using ith of a technological method for production of planned amount of products.

Stage III. Solution of a static task of optimization of technological methods of production.

3.1. By means of the modified simplex method intended for the solution of a task of linear integer programming the problem of 1 optimization of engineering procedures at the entity (is solved in case of the set planned production volumes of all products, products remaining balance in stock, costs for storages of products, all technological costs and the predicted prices for products) with linear functionality of $\Phi_{\overline{t,t+1}}$ which is described by ratios Eqs. (1)-(4). As a result of the solution of this task the set of $U^{(e)}(t) \subseteq U^*(t)$ of optimum vectors of $u^{(i^{(e)})}(t) \in U_*^{(e)}(t)$ (optimum technological methods of production of intensity) for which value of total amount of profit on production and sales of products of the entity in the period of time of $\overline{t, t+1}$ is maximum is formed, i.e. they satisfy to a ratio Eq. (5).

Stage IV. Display of results.

4.1. The results received at the previous stage III are formed in the form of schemes of the engineering procedures corresponding to values of optimum vectors $u^{(i^{(e)})}(t) \in U^{(e)}(t)$ and displayed in the form convenient for the persons making decisions at the entity.

Let's note that concrete expressions of values of all parameters appearing in this algorithm pay off according to standard techniques [5, 6].

2. Dynamic model of optimization of integrated management of engineering procedures at the entity

Let's assume that for every period of time of $t \in \overline{0, T-1}$ in process of management of engineering procedures at the entity the generalized condition of profitability of production determined by a ratio Eq. (6) is satisfied.

Then for forming of dynamic model we will enter the following designations:

$Q(t+1) = (Q_1(t+1), Q_2(t+1), \dots, Q_n\ (t=1)) \in R^n$ – a vector of amounts of products formed in stock in the period of time of $t+1$ $(t \in \overline{0, T-1})$ i.e. inventories in the period of $(t+1)$ which each kth the coordinate of $Q_k(t+1)$ has a value of amount of products kth of a type $(k \in \overline{1, n})$;

$A(t) = \|a_{jj}(t)\|_{j\in\overline{1,n}}$ – is the diagonal matrix characterizing "aging" of products in stock for the period of time of $(t \in \overline{0,T-1})$;

$R_i^{(p)}(t) = \left(R_1^{(p,i)}(t), R_2^{(p,i)}(t), \dots, R_n^{(p,i)}(t)\right) \in R^n$ – a vector of amounts of the sold planned products in the period of time of t $(t \in \overline{0,T-1})$ made when using ith a technological method of the production at the entity corresponding to value of a vector of its intensity $u^{(i)}(t) = \left\{d_1^{(i_1)}(t), u_2^{(i_2)}(t), \dots, u_n^{(i_n)}(t)\right\} \in U^*(t)$, and each kth the coordinate of $R_k^{(p,i)}(t)$ is value of amount of products kth of a type $(k \in \overline{1,n})$;

$c^{(r)}(t) = \left\{c_1^{(r)}(t), c_2^{(r)}(t), \dots, c_n^{(r)}(t)\right\} \in R^n$ – a vector of actual prices for products of the entity in the period of time of t $(t \in \overline{0,T-1})$ in which for each $k \in \overline{1,n}$ value of coordinate $c_k^{(r)}(t)$ is real unit price of products of kth of a type for the same period of time.

Then we will create the following recurrent system of the equations:

$$\begin{cases} Q(t+1) = A(t)Q(t) + Q_i^{(p)}(t) - R_i^{(p)}(t), \\ P(t+1) = P(t) + \left\langle c^{(r)}(t), R_i^{(p)}(t)\right\rangle_n - \langle z(t), Q(t)\rangle_n - \left\langle Z_i^{(p)}(t), u^{(i)}(t)\right\rangle_n, \end{cases} \tag{7}$$

where $Q(t) = (Q_1(t), Q_2(t), \dots, Q_n(t)) \in R^n$ – a vector of amounts of a remaining balance of products which are stored in stock in the period of time of t $(t \in \overline{0,T-1})$; $Q_i^{(p)}(t) = \left(Q_1^{(p,i)}(t), Q_2^{(p,i)}(t), \dots, Q_n^{(p,i)}(t)\right) \in R^n$ – a vector of planned volumes of production of the entity in the period of time of t $(t \in \overline{0,T-1})$ made when using ith a technological method of production; $P(t)$ – the size of amount of profit of the entity for the period time of $\overline{0,t}$; $z(t) = \{z_1(t), z_2(t), \dots, z_n(t)\}$ – a vector of warehouse costs in the period of time t $(t \in \overline{0,T-1})$ and a vector of $Z_i^{(p)}(t) = \left\{Q_1^{(p)}(t)d_1^{(i_1)}(t), Q_2^{(p)}d_2^{(i_2)}(t), \dots, Q_n^{(p)}d_n^{(i_n)}(t)\right\}$ – a vector of all costs of the entity when using ith of a technological method in the period of time of t $(t \in \overline{0,T-1})$.

For an efficiency evaluation of the solution of a dynamic task of optimization of management of engineering procedures at the entity the functionality of $\Phi_{\overline{0,t+1}}$ which values for all vectors of $u_{t+1}^{(i)}(\cdot) = \left\{u_{t+1}^{(i)}(\tau), \forall\, \tau \in \overline{0,t}, u_{t+1}^{(i)}(\tau) \in U^*(t)\right\}$ of intensity of ith a technological method of production, are calculated on the following formula:

$$\Phi_{\overline{0,t+1}}\left(u_{t+1}^{(i)}(\cdot)\right) = \sum_{\tau=0}^{t} \left[\left\langle c(\tau)Q^{(p)}(\tau)\right\rangle_n - \langle z(\tau), Q(\tau)\rangle_n - \left\langle Z_i^{(p)}(\tau), u_{t+1}^{(i)}(\tau)\right\rangle_n\right], \tag{8}$$

is entered into the considered period of time of $\overline{0,t+1}$ $(t \in \overline{0,T-1})$ based on Eq. (1) and are equal to the total amount of profit of the entity during this period of time.

Let's note that parameters of a ratio Eq. (8) have to satisfy to restrictions Eqs. (2), (3) and all coordinates of the considered vectors are integer.

Let's assume that for the entire periods of time of $t \in \overline{0,T-1}$ for this task the condition Eq. (6) is satisfied, i.e. there is a vector of $u^{(i)}(t) = \left\{u_1^{(i)}(t), u_2^{(i)}(t), \dots, u_n^{(i)}(t)\right\} \in U^*(t)$ determining intensity of use of ith a technological method of production at the entity in case of which implementation production is profitable.

Then the solution of a task 2 [3] – dynamic optimization of integrated management of engineering procedures at the entity (in case of the set planned production volumes, products remaining balance in stock, all storage costs of products, all technological costs and the predicted prices for products) will consist in finding of the optimum sequence of vectors of $\{u^{(i^{(e)})}(\tau)\}_{\tau\in \overline{0,t}}$, $\forall\, \tau \in \overline{0,t}$, $u^{(i^{(e)})}(\tau) \in U^*(\tau)$ (optimum technological methods of production of intensity) and $\{Q^{(e)}(0), P^{(e)}(0)\}, \{Q^{(e)}(1), P^{(e)}(1)\}, \dots, \{Q^{(e)}(t), P^{(e)}(t), \{Q^{(e)}(t+1), P^{(e)}(t+1)\}$ corresponding to it the integer trajectory determined from system of the recurrent Eq. (8) and to the satisfying system of restrictions of a type Eq. (2) which in total bring the maximum value of the criterion function of a type Eq. (8) created for each timepoint $t \in \overline{1,T}$, i.e. value of total amount of profit on production and sales of products of the entity in the period of time of $\overline{0,t+1}$ calculated according to Eq. (8) will be maximum (due to minimization of all expenses of the entity).

The technique of forming of input data for dynamic model of optimization of integrated management of engineering procedures at the entity which is based on the available statistical data and quarterly accounting records of the considered entity is offered [4, 7].

The algorithm of dynamic optimization within the formalized model Eqs. (7), (8), (2), (3) was developed for computer implementation of the solution of a task 2. The general scheme of an algorithm of the solution of a task of optimization of integrated management of engineering procedures at the entity for each timepoint of $t \in \overline{1,T}$ can be represented as the following main sub-tasks.

1) Formation of basic data from an algorithm 1.

2) Formation of a set of all admissible operating influences of $U^*(t)$.

3) The solution of a static task 1 maximizing linear functionality of $\Phi_{\overline{t,t+1}}\left(u^{(i)}(t)\right)$ set by a Eq. (1) at $u^{(i)}(t) \in U^*(t)$ (by means of the corresponding modification a simplex method for the solution of a problem of linear integer programming) as a result of which the vector of $u^{(i^{(e)})}(t) \in U^{(e)}(t)$ and the optimum (maximum) value of functionality $\Phi^{(e)}_{\overline{t,t+1}} = \Phi_{\overline{t,t+1}}\left(u^{(i^{(e)})}(t)\right)$ corresponding to him is formed.

Formation of set of vectors of $\left\{R^{(p)}_{i^{(e)}}(t), c^{(r)}(t)\right\}$.

On the basis of system of the recurrent Eq. (7), formation of set of vectors of $\left\{Q^{(e)}(\mathrm{t}+1), P^{(e)}(t+1)\right\}$, where $Q^{(e)}(t+1) = A(t)Q(t) + Q^{(p)}_{i^{(e)}}(t) - R^{(p)}_{i^{(e)}}(t)$; $P^{(e)}(t+1) = P(t) + \left\langle c^{(r)}(t), R^{(p)}_{i^{(e)}}(t)\right\rangle_n - \langle z(t), Q(t)\rangle_n - \left\langle Z^{(p)}_{i^{(e)}}(t), u^{(i^{(e)})}(t)\right\rangle_n$.

Calculation on a Eq. (8) of value of functionality $\Phi_{\overline{0,t+1}}\left(u^{(i^{(e)})}_{t+1}(\cdot)\right)$ at $u^{(i)}_{t+1}(\cdot) = u^{(i^{(e)})}_{t+1}(\cdot)$, $c(t) = c^{(r)}(t)$, $Q^{(p)}(t) = R^{(p)}_{i^{(e)}}(t)$.

Display of results of the solution of tasks in the form convenient for the persons making decisions at the entity.

The given algorithm represents implementation of the solution of a dynamic (multistep) task of optimization of integrated management of engineering procedures at the entity by forming of the optimum managements which are solutions of the corresponding single-step (static) tasks of optimization of integrated management of engineering procedures on the considered periods of management.

3. Conclusions

Static and dynamic economic-mathematical models for the solution of tasks of information support and optimization of integrated management of engineering procedures at the entity are offered.

Within static and dynamic economic-mathematical models of the solution of tasks of information support and optimization of integrated management of engineering procedures at the entity algorithms their solutions allowing to create effective management decisions are proposed.

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