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DEVELOPMENT DESIGN MODEL FOR HARDWARE OF INFROMATION SYSTEM OF ECONOMIC OBJECT

Abstract. *Article studies a problem of planning for hardware of information system of economic object. There have been analyzed the peculiarities of maintenance of information system hardware, which should be considered when solving planning tasks. Mathematical model of hardware planning has been proposed, which is oriented to informational supply of business processes of economical objects at minimizing expenses for documents processing.*

Keywords*: information system, hardware, economic object, business process, mathematical model.*

I. Introduction

Working capacity and efficiency of information system depends greatly on the state of its components: hardware, software, mathematical and staff support.

As a rule, hardware planning is considered as a task of generating the procurement schedule, modernization and change of industrial equipment which is used for production [1–3]. Though planning task for technical facilities of economic object consists in generating the optimal plan for changing the equipment using a dynamic programming method [2].

Being presented in [1] the complex of mathematical models studies a system of technical facilities of economic object within its progress and includes: a model of design planning, a model of procurement planning, and a model of facility using. The main criteria of an optimal plan of technical facilities progress in [1] are: expenses for design, purchasing, storage and using of technical facilities; time periods of planning; production and purchase volumes; working capacity of technical facilities. Problem investigating for changing of industrial equipment is given in monograph [3], whose authors made detailed analysis of vital model for equipment changing, computation methods for amortization and corresponding methods for expenses account for operating the equipment, its physical and moral wear out.

But existing models [1-3] are of little avail for planning of technical facilities of information system for they do not consider their operational and wear features, as well as do not combine planning process with the main task of information system – providing information for business processes of economic object control. Among the operational features of technical facilities of information system we distinguish the following [4–6]:

– In the majority of event information systems do not participate themselves in production process, but their main task is information supply for business processes of economic object control;

– Results on information system operation are not revealed at once but with some lag.

II. Problem statement

Aim of the article is to develop a mathematical model of planning the technical facilities of information system during its design basing the values of informational support of business processes of economic object control.

III. Results

Assessment of informational support of business processes will be performed using the following indicators: specific amount of business processes, handling by information system, and expenses for documents processing accompanying theses business process [4].

To describe a planning model for technical facilities we shall take a part of definitions from [1], having added them with variables, which reflect the peculiarities of informational support of business processes [4]:

$\mathbf{T} = \{1,...,T\}$ – array of unit time intervals to which all planning period is divided;

$\mathbf{I} = \{1,...,m\}$ – array of samples of technical facilities of information system;

$\mathbf{P} = \{1,...,m\}$ – array of price samples of technical facilities of information system;

$\mathbf{K} = \{1,...,k\}$ – array of business processes served by technical facilities of information system;

$\mathbf{J} = \{1,...,j\}$ – array of documents accompanying business processes of economic object;

$\mathbf{A} = \{1,...,n\}$ – array of personal data in the documents;

C_{B_t} – expenses for purchasing technical facilities of information system at t section;

C_{M_t} – operating costs of technical facilities of information system at t section;

C_{R_t} – repair costs of technical facilities of information system at t section;

$C_{S_{it}}$ – utilization costs per unit of technical facilities of information system of *i-type* at t section;

L_{it} – limits for purchase volume of technical facilities of information system of *i-type* at t section;

U_{kt} – limits for permissible minimum level of information support of k-numbered business process at t section ($0 < U_{kt} \le 1$);

W_{it} – limits for utilization volume of technical facilities of information system of *i-type* at t section;

R_t – limits for resource amount evolved into development of technical facilities of information system at t section;

b_{it} – number of technical units of information system of *i-type* purchased at t section;

o_{it} – number of technical units of information system of *i-type*, taking out of operation at t section;

u_{it} – number of technical units of information system of *i-type*, which economical object has at t section.

Implementation of new business processes must be followed by creating automated working places for which the new equipment has to be bought and which cost price is C_{HW}: personal and network computers, network equipment (commuters, routers etc.) and peripheral facilities (printers, scanners etc.). Purchase costs also include expenses for purchase department C_{PE}, juridical and financial departments C_{LA}, logistics expenses C_T, as well as possible risks r. Risks in this case assess possible loses over bad quality service and opportunism of suppliers, bankruptcy loses and others. So, expenses for buying technical facilities of information system can be calculated by formula:

$$C_{B_t} = \sum_{i=1}^{m} C_{HW_{it}} + C_{PE_t} + C_{LA_t} + C_{T_t} + r_t. \qquad (1)$$

Maintenance expenses (operation and current maintenance) of technical facilities of information system include: cost of consumed power C_{EP}, cost of expenditure materials C_{EX}, cost of premises maintenance C_R, salary of workers of technical department of IT-service S_P, and other expenses C_O:

$$C_{M_t} = \sum_{i=1}^{m} \left(C_{EX_{it}} + C_{EP_{it}}\right) + C_{R_t} + S_{P_t} \cdot T_{mn} + C_{O_t}, \qquad (2)$$

where T_{mn} – share of working time of workers of IT technical department service, used for maintenance of information system.

Expenses for repairing technical facilities of information system are assessed after the end of warranty period and include: cost of replacement parts C_{RP}, expenses for work of purchase and financial department C_{SA}, transport expenses C_T, salary of workers of technical department of IT service S_P:

$$C_{R_t} = \left[\sum_{i=1}^{m} C_{SP_{it}} + C_{SA_t} + C_{T_t} + S_{P_t} \cdot T_{rec}\right] \cdot e^{\alpha(t-\tau_G)}, \qquad (3)$$

where t – a time moment, which is used to assess expenses;

T_{rec} – part of working time of technical department personnel of IT service, which is used for repairing of technical facilities of information system;

τ_G – warranty term for technical facilities;

α – expenditures grow speed for repairing of technical facilities of information system.

In formula (3) a factor $(t-\tau_G)$ defines a lug equal to warranty period τ_G of new technical devices, which includes transfer of expenses to repair works by the end of this period (let's accept, that during warranty period all expenses for repair works bears supplying company). For simplification we accept for all kinds of technical facilities of information system the same warranty period.

Specific expenses C_j^k to process j-operator document, which is used in k-operator business process, is calculated by formula:

$$C_j^k = \frac{T_{Doc_j}^{\ k}}{T_F^{\ k}} \cdot \frac{C_M\left(T_F^{\ k}\right) + C_R\left(T_F^{\ k}\right) + S_{IT}\left(T_F^{\ k}\right) + S_{MN}\left(T_F^{\ k}\right)}{N_{Doc}^{\ k}}, \qquad (4)$$

where $T_{Doc_j}^{\ k}$ – time used for preparation of j-operator document, which is used in k-operator business process;

$T_F^{\ k}$ – time used for preparation of all documents in k-operator business process;

$N_{Doc}^{\ k}$ – number of documents used in k-operator business process;

$C_M\left(T_F^{\ k}\right)$, $C_R\left(T_F^{\ k}\right)$ – maintenance and repair expenses for technical facilities of information system, which are used in k-operator business process, and computed for the period $T_F^{\ k}$;

$S_{IT}\left(T_F^{\ k}\right)$, $S_{MN}\left(T_F^{\ k}\right)$ – salary with deductions for IT staff and managers, involved in k-operator business process computed for the period $T_F^{\ k}$.

Let's set the task of planning the technical facilities of information system like maximization of information support of managerial business processes of economic object at minimum cost for processing documents accompanying these business processes:

$$NBIS \to \max, \quad \sum_{k=1}^{NB} \sum_{j=1}^{D_k} C_j^k \to \min, \qquad (5)$$

where $NBIS$ – specific number of business processes maintained by information system of economic object;

NB – number of business processes of economic object, which are maintained by information system;

D_k – total number of documents being processed by information system at maintaining the k-operator business process;

C_j^k – expenses for processing j-operator document, which is used in k-operator business process,

At limitations:

$$u_{it} = u_{it-1} + b_{it} - o_{it}, \quad (6)$$

$$NBIS_{kt} \geq U_{kt}, \quad (7)$$

$$P_i \cdot b_{it} \leq L_{it}, \quad (8)$$

$$o_{it} \leq W_{it}, \quad (9)$$

$$\sum_{i=1}^{m} C_{S_{it}} + C_{B_t} + C_{M_t} + \leq R_t, \quad (10)$$

$$u_{it}, b_{it}, o_{it}, C_{B_t}, C_{M_t}, C_{S_{it}} \geq 0,\ 0 < U_{kt} \leq 1,\ i \in \mathbf{I},\ t \in \mathbf{T}, k \in \mathbf{K}. \quad (11)$$

When operating technical devices of information system expenditure sum for their repair C_R, maintenance C_M and utilization C_s must not exceed benefits π_t, obtained from using the subsystems of information system, which maintain these technical facilities:

$$C_{R_t} + C_{M_t} + \sum_{i=1}^{m} C_{S_{it}} \leq \pi_t. \quad (12)$$

Benefit value of information system π_t we obtain using proper mathematical models. By putting into operation new technical facilities of information system there is no sufficient data, so it is reasonable to use cognitive maps [7] and fuzzy production models [8], which provide obtaining preliminary assessment of receiving benefits. At the stage of operating technical facilities of information system it may be possible to use econometric [5] and neural network [6].

As initial time moment $t = 0$ in (2)–(12) let's accept the moment, when economic object starts spending costs to purchase technical facilities for development of information system.

Taking out of operation existing technical devices of information system and buying new ones will be performed only if amortization payments are finished and a condition (12) is broken.

Each document is generated several times a year and is stored the proper years. As a result we have a number of information required to information support of new and alive business processes:

$$N_I = \sum_{i=1}^{m} \sum_{k=1}^{BP_i} \sum_{j=1}^{D_k} \left[NG_j \cdot ST_j \cdot \sum_{n=1}^{P_j} A_{nj} \right], \quad (13)$$

where BP_i – number of business processes which are carried out when putting into operation i-operator technical facilities of information system;

D_k – number of documents accompanying k-operator business process;

NG_j – number of generations of j-operator, units per year;

ST_j – storing period of j-operator document, years;

P_j – number of requisites in j-operator document;

A_{nj} – volume of n-requisite in j-operator document.

Formula (13) allows determining volumes of storage of information system data, requiring to provide information support for business processes and documents turnover of economic object. These data are necessary to assess the necessity of buying technical facilities for data storages of information system.

Thus, planning of technical facilities of information system includes in distributing within time the operations on their purchasing, repairing and operation if conditions (5-12) are performed.

A plan usually is made for several years, so it has uncertainty of indexes in equations (1)-(13). This uncertainty can be accounted if insert the indexes in model equation in the form of neutral numbers or neutral intervals [8].

IV. Conclusions

1. When planning technical facilities during development of information system of economic object one have to take into consideration their operational conditions: in most cases information systems do not participate themselves in production processes and results of their application can be revealed immediately, but with some lag. At this the main task of information system is to provide information all business processes for controlling the economic object.

2. Mathematical model is offered for planning technical facilities of information system, based on maximization of information support of managerial business processes by economic object considering costs for purchasing, maintenance and repair of technical devices at minimization of expenses to information support of business processes.

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