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METHODS OF ASSESS THE IMPACT OF TECHNOLOGICAL VARIABLES COMPLEX SPATIAL-DISTRIBUTED SYSTEMS ON COSTS

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ABSTRACT

The paper considers the method of calculating costs, taking into account the effect of technological parameters; the model of forecasting of costs of production resources based on the matrix of costs are described; the methods of assess the impact of parameters of complex spatial-distributed systems on costs are presented.

Keywords: *METHOD OF CALCULATION, MATHEMATICAL MODEL, SYSTEM, COMPLEX, PROCESS..*

I. INTRODUCTION

For analyzing the dependency of costs on the thickness and width of metal, matrices of costs for the particular cost elements and total costs on the stage of processing or assembly can be built. Such matrices are constructed for each steel grade separately.

If the defining technological parameters for all cost elements are known, we can calculate these costs during the study period.
Initial data are:

- The data array on volumes of industrial products M;
- Array of the defining technological parameters for each element of cost X^Z;
- Diagonal matrix of the coefficients of proportionality for each element of cost K^{ZX} (the number of elements of costs P).

In matrix form:

$$(M*X^{(Z)})*K^{(ZX)}=Z \quad (1)$$

On the first stage of the research, the matrix of proportionality $K^{(ZX)}$ is unknown. Having the initial data for a definite base period (for example, for the month) on production volumes $M_Б$, processing technologies $X_a^{(Z)}$ and expended resources $Z_Б$, a matrix $K^{(ZX)}$ can be achieved.

$$\left(M_a * X_a^{(Z)}\right) * K^{(ZX)} = Z_a \quad (2)$$

Multiplying by the inverse matrix:

$$\left(M_a * X_a^{(Z)}\right)^{-1} * \left(M_a * X_a^{(Z)}\right) * K^{(ZX)} = \left(M_a * X_a^{(Z)}\right)^{-1} * Z_a \quad (3)$$

As the result, we have:

$$K^{(ZX)} = \left(M_a * X_a^{(Z)}\right)^{-1} * Z_a \quad (4)$$

On the basis of generalized matrices of coefficients of proportionality K_{Σ_I} for each of the studied period, resource consumption forecast in all ratios on other periods can be realized K_{Σ_I} .

Using a matrix of coefficients of proportionality during the base period and total consumption of technological parameters during the studied period , it is possible to predict the consumption of resources in the current period according to basic coefficients [5,7,8].

(5)

where
– is the matrix of total costs during the studied month on the basic;
– is a diagonal matrix of the studied period;
– is the matrix of coefficients of the base period.

Similarly, the matrix of forecasts on all *I* studied periods according to the coefficients of proportionality of basic *J* periods are defined.

$$Z_{\Sigma(I,J)} = diag(M \cdot X_{\Sigma})_{(I)} \cdot K_{\Sigma(J)} \quad (6)$$

If T of periods is explored, then the final matrix of the forecasts will contain [*T* (the number of matrices $K_{\Sigma(J)}$)] $\cdot$ [(*T*-1) (the number of predicted periods), i.e $diag(M * X_{\Sigma})_{(I)}$] = [*T**(*T*-1)] lines.

The final table for each cost element has the following form (table 1).

Table 1

The model of calculation of cost items

Forecasts of costs according to periods	Technological parameters					The actual consumption of resources $Z_{R(I)}$
	X_1	X_2	X_3	…….	X_k	
the forecast for the period 1 on the period 2						$Z_{R(1)}$
the forecast for the period 1 on the period 3		$Z^{X_K}_{R(I,J)}$				$Z_{R(2)}$
……………..						…………
the forecast for the period T on the period (T-1)						$Z_{R(12)}$

Note to the table 1:

X_k – is technological parameter of period *k*; $Z^{X_K}_{R(I,J)}$ - is the value of the forecast for the *J* period of consumption of the *R* resource according to the data of the *I* period in the X_k parameter.

To assess the influence of particular parameters on the cost elements, the separate matrices of forecasts for each parameter X_n are built (table 2).

Table 2

Matrix of forecasts for the parameter X_n on T periods

Base periods (*J*)	The studied periods (*I*)						
	1	…	*J*	*I*	…	*T-1*	*T*
1	$Z_{R(1)}$						
…							
J			$Z_{R(J)}$	$Z_{R(InoJ)}$			
…							

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T-1							
T							$Z_{R(p)}$

If the numbers of the base and studied periods are equal (I=J) in the table 2, then $Z_{R(InoJ)}$ the actual consumption of resources during the studied period $Z_{R(J)}$ is noted. As the result, it is possible to get average forecasts for particular periods and for the entire studied period (e.g. a year). The average error of forecasts for the period on the studied parameter X_L :

$$\bar{\varepsilon}_{R(I)}^{X_L} = \frac{\sum_{J=1}^{T} \left| \frac{Z_{R(I)} - Z_{R(IJ)}^{X_L}}{Z_{R(I)}} \right|}{T} \tag{7}$$

where

$Z_{R(I)}$ - is the actual consumption of resource R during the studied period *I*;

$Z_{R(IJ)}^{X_L}$ - are projected costs of the *R* resource on a complex of X_L parameters for the *I* period in the matrix of basic coefficients for the *J* period;

T – is the number of projected periods.

The average error for the entire projected period for each technological parameter

$$\bar{\varepsilon}_{R}^{X_L} = \frac{\sum_{i=1}^{I} \bar{\varepsilon}_{R(I)}^{X_L}}{I} \tag{8}$$

An example of a forecast of resource consumption depending on technological parameters is given in the table 3.

Table 3

The forecast of electric energy consumption on the total compression, kW h

electric energy	January	February	March	April	may	June	July	August	September	October	November
January	**37561,9**	32831,56	36224,41	37126,2	35152,46	32464,75	33820,29	34183,49	36334,45	21470,35	20723,6
February	39837,2	**34820,3**	38418,7	39375,1	37281,8	34431,3	35868,9	36254,1	38535,4	22770,9	21978,9
March	37625,9	32887,5	**36286,1**	37189,4	35212,3	32520,0	33877,9	34241,7	36396,3	21506,9	20758,9
April	36125,78	31576,3	34839,43	**35706,74**	33808,46	31223,51	32527,23	32876,54	34945,26	20649,47	19931,27
may	37930,08	33153,37	36579,48	37490,11	**35497,02**	32782,97	34151,8	34518,55	36690,6	21680,8	20926,73
June	38387,54	33553,23	37020,66	37942,27	35925,14	**33178,36**	34563,69	34934,87	37133,12	21942,29	21179,13
July	39445,34	34477,82	38040,79	38987,8	36915,09	34092,61	**35516,13**	35897,53	38156,35	22546,93	21762,73
August	39183,54	34248,98	37788,31	38729,03	36670,08	33866,34	35280,4	**35659,27**	37903,1	22397,28	21618,29
September	36808,51	32173,05	35497,85	36381,55	34447,39	31813,59	33141,95	33497,86	**35605,68**	21039,71	20307,94

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October	37157,86	32478,41	35834,77	36726,85	34774,34	32115,55	33456,51	33815,79	35943,62	**21239,41**	20500,69
November	37748,94	32995,04	36404,79	37311,07	35327,5	32626,41	33988,7	34353,7	36515,38	21577,26	**20826,79**
the average on the month	38025,07	33037,53	36664,92	37725,95	35551,47	32793,71	34067,75	34457,42	36855,37	21758,2	20968,83
error	2,6	5,1	2,6	5,7	2,6	2,9	4,8	3,8	3,9	3,2	2,5
the average error	**3,6**										

Using the data of the table 1 it is possible to construct a regression model of dependency of the actual consumption of resources from the predicted values of technological parameters.

$$Z_i = b_0 + \sum_{j=1}^{K} b_j \cdot Z_{i(I,J)}^{X_j}, i = 1,...,R \tag{9}$$

Since the values of actual and projected consumption of resources are comparable in size, the coefficients of the b_j model allow estimating the impact of the predicted value of the cost element according to the corresponding technological parameter on the real value of the studied resource [1-4, 6, 8]. It is possible to evaluate the effectiveness of the use of particular parameters for the cost forecast by receiving correlation matrix in the table 1.

Correlation and regression analyses allow estimating the influence of parameters without getting $Z_i^{X_j}$ forecasts. In this case, it is possible to evaluate the influence of the total consumption of each technological parameter $\sum_n MX_k$ on the cost elements. Table 4 is formed here.

Table 4

Total consumption of technological parameters and the cost elements

period	products	weight	technological parameters			Total consumption of technological parameters $\sum_{i=1}^{n} m_i x_{ji}$			the cost elements		
			X_1	…	X_K	X_1	…	X_K	Z_1	…	Z_P
1	1 … n	m_{11} …. m_{n1}	x_{11} … x_{1n}		x_{K1} … x_{Kn}	$\left(\sum_{i=1}^{n} m_i x_{1i}\right)_1$	…	$\left(\sum_{i=1}^{n} m_i x_{Ki}\right)_1$	Z_{11}		Z_{P1}
…											

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T	1 … n	m_{1T} …. m_{nT}	x_{11} … x_{1n}		x_{K1} … x_{Kn}	$\left(\sum_{i=1}^{n} m_i x_{1i}\right)_T$		$\left(\sum_{i=1}^{n} m_i x_{Ki}\right)_T$	Z_{1T}		Z_{PT}

The mass of products, which is realized for all the elements of the alphabets b_{kj_k} of these parameters $m_{b_{kj_k}t}$ during the studied period t (table 5), is determined to assess the impact of technological factors on the consumption of resources.

Table 5

The distribution of mass of products according to elements of the alphabets of the parameters

perio d	technological parameters											the cost elements		
	X_1					…	X_K							
	b_{11}	…	b_{1j_1}	…	b_{1J_1}		b_{K1}	…	b_{Kj_K}	…	b_{KJ_K}	Z_1	…	Z_P
1	$m_{b_{11}1}$		$m_{b_{1j_1}1}$		$m_{b_{1J_1}1}$		$m_{b_{K1}1}$		$m_{b_{Kj_K}1}$		$m_{b_{KJ_K}1}$	Z_{11}		Z_{P1}
…														
T	$m_{b_{11}T}$		$m_{b_{1j_1}T}$		$m_{b_{1J_1}T}$		$m_{b_{K1}T}$		$m_{b_{Kj_K}T}$		$m_{b_{KJ_K}T}$	Z_{1T}		Z_{PT}

According to the obtained data from the table 5, it is possible to construct models of forecast of the resource consumption from "total consumption" of technological parameters according to their distribution on the alphabet elements.

$$Z_p = c_0 + \sum_{k=1}^{K} \sum_{j_k=1}^{J_k} c_{kj_k} m_{b_{kj_k}} \tilde{b}_{kj_k}, p = 1,..,P \qquad (10)$$

where $\tilde{b}_{kj_k}$ - is the average value of the alphabet element.

II. CONCLUSION

1. The algorithms and models of requirement forecast in the resources for production are developed, allowing to provide us with a more detailed cost information and to help in price fixing for different types of products, significantly reducing response times to changing economic and technological situation.
2. Methods of evaluation the impact of parameters of complex spatial-distributed systems on costs are introduced.

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