Implementation of Modern Management Technologies in Enterprise Economic Security

Viktoriia Kryvdyk [1], Yevhenii Rudnichenko [1], Nataliia Havlovska [1], Serhii Matiukh [1],Valeriy Harbusiuk [1], Oksana Samborska [2]

[1] *Khmelnitsky National University, Khmelnitsky, Ukraine*
[2] *Vinnitsa State Pedagogical University, Vinnitsa, Ukraine*

***Abstract* – The article examines the realm of management technologies, focusing on 25 key tools and their current trends of application. The specific factors influencing the enterprises of the construction industry are distinguished and the main risks affecting their activities are determined. In addition, a model of introducing modern management technologies into the economic security system of the enterprise is proposed. The proposed model was tested at the enterprise Supplementary Liability Company (SLC) "Khmelnitskhezelezobeton". During the approbation, 35 experts from among management and production personnel were involved at the enterprise, which allows us to draw conclusions about the representativeness of the sample and the reliability of the obtained data at the enterprise. The proposed model allows to choose the most effective modern management technologies (out of the 25 listed), which will contribute to the stable functioning of the enterprise's economic security system by neutralizing risks. Five tools and technologies have been identified for SLC "Khmelnitskhezelezobeton": benchmarking, complexity reduction, customer segmentation, digital transformation, mergers and acquisitions.**

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Corresponding author: Yevhenii Rudnichenko, *Khmelnitsky National University, Khmelnitsky, Ukraine*
Email: e.m.rudnichenko@gmail.com

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1. Introduction

The variability of the external environment and the acceleration of the development of socio-economic systems necessitate the search for new technologies and management tools. Modern management technologies allow enterprises to automate processes, increase labor productivity, make informed decisions, etc.

The choice of management technologies in the practical activities of domestic enterprises depends on the goals of their application and the purpose of the business entity's functioning. The purpose of the operation of most enterprises is to increase their market value, increase business profitability, and increase the welfare of business owners [5]. As for management technologies, the purpose of their application lies in practical activities of enterprises, based on essential components, which are maintaining a stable mode of operation of a management system; effective achievement of set goals; implementation of the most effective methods and tools in practical activities; awareness of all processes that take place at an enterprise, as well as between an enterprise and external environment; consistency; prevention, overcoming the crisis, reducing the level of its negative consequences; efficient use of resources and improvement of indicators of production and economic activity of an enterprise.

The term technology (the science of technology) was introduced into scientific circulation in 1772 by J. Bekman. As for technology in general, etymologically translated from Greek it means téchne – art, skill; logos – teaching. In a broad sense, it is understood as the amount of knowledge that is used to produce goods and services from economic resources [6].

Scientists understand by technology the study and knowledge of practical, in particular industrial, use of scientific discoveries [3], the use of organized knowledge to solve practical problems by organized systems of people and machines [1], the practical application of knowledge in one or another field; the way of performing a task, in particular with the use of technical processes, methods or knowledge, specialized aspects of a specific field of activity [9]. Management technologies are a purposeful process based on knowledge, experience and intuition, implemented within management functions using methods and tools and aimed at achieving the desired results.

Since 1993, Bain&Company has been conducting research on the popularity of management tools and existing trends (Management Tools & Trends) based on a survey of heads of organizations around the world [7].

This study is based on the evaluation of 25 instruments, which include:

1) advanced analytics;
2) agile management;
3) balanced scorecard;
4) benchmarking;
5) business process reengineering;
6) change management programs;
7) complexity reduction;
8) core competencies;
9) customer journey analysis;
10) customer relationship management;
11) customer satisfaction systems;
12) customer segmentation;
13) digital transformation;
14) employee engagement surveys;
15) internet of things;
16) mergers and acquisitions;
17) mission and vision statements;
18) organizational time management;
19) price optimization models;
20) scenario and contingency planning;
21) strategic alliances;
22) strategic planning;
23) supply chain management;
24) total quality management; and
25) zero-based budgeting.

Such tools are quite specific and require taking into account the parameters of functioning of enterprises for a specific industry, which was considered in the study. The main risks and specific features of the functioning of enterprises were taken into account. Since the model was developed for enterprises in the construction industry, the main features of running such a business include:

1) seasonality;
2) resource provision;
3) institutional restrictions;
4) market conditions;
5) socio-economic situation.

Accordingly, the main risks include:

1) a drop in demand;
2) increase in the cost of resources;
3) lack of employees with appropriate qualifications;
4) lack of working capital;
5) presence of technological failures;
6) increasing competition (price, quality, new types of products from competitors, alternative technologies);
7) decrease in the level of safety culture at the enterprise;
8) reducing the level of managerial influence on processes and operations;
9) decrease in the quality of internal economic control;
10) infrastructure restrictions.

The choice of management technologies depends on the specific operating conditions of an enterprise, which depends on the industry and specifics of the activity, as well as on the risks affecting the enterprise. That is why this article is devoted to taking into account possible factors influencing the enterprise's activity and the peculiarities of its choice of management technologies.

2. Research Method

The method of expert assessments and the subsequent formation of a cumulative matrix with an appropriate assessment of existing risks and available tools and technologies became the base for our research methodology. This makes it possible to determine the nominal vector of the effectiveness of management tools for decision-making by the management of the enterprise.

In the general case, let us have N operating conditions of the enterprise and S types of risk. Let a_{ns} is the cumulative value (estimate) of the impact of a s-th type of risk on the n-th condition, $a_{ns} \in \{0, 1, 2, ...\}$. If $a_{ns} = 0$, then this means that a s-th type of risk does not affect a n-th condition of enterprise's functioning at all. The greater the value of a_{ns} (it will be an integer), the stronger (and negative) this influence is. The entire set of assessments of the impact of risks on operating conditions of an enterprise will be presented in the form of a cumulative matrix:

$$\mathbf{C}_R = \left[a_{ns} \right]_{N \times S} \tag{1}$$

For the convenience of further calculations, this matrix should be normalized by rows [11], [12]:

$$\tilde{a}_{ns} = \frac{a_{ns}}{\max_{j=\overline{1,S}} a_{nj}} \quad (n = \overline{1,N} \text{ та } s = \overline{1,S}) \tag{2}$$

Then we will have a normalized cumulative matrix:

$$\tilde{\mathbf{C}}_R = [\tilde{a}_{ns}]_{N \times S} \tag{3}$$

in which, as a result of normalization according to (2), each row contains at least one unit.

Let b_{sm} be the cumulative value (estimate) of the power of influence (efficiency) of the *m*-th tool or technology to eliminate (neutralize) the *s*-th type of risk, $b_{sm} \in \{0, 1, 2, \ldots\}$. If $b_{sm} = 0$, then this means that the *s*-th type of risk cannot be eliminated at all with the help of the *m*-th tool. More precisely, in such a case, this tool has zero effectiveness. The greater the value b_{sm} (it will be an integer), the more effective *m*-th tool for neutralizing the *s*-th type of risk is. The entire set of assessments of the effectiveness of risk neutralization tools for an enterprise will be presented in the form of a cumulative matrix:

$$R_M = [b_{sm}]_{S \times M} \tag{4}$$

As in the case of matrix (1), for the convenience of further calculations, this matrix should be normalized in rows:

$$\tilde{b}_{sm} = \frac{b_{sm}}{\max_{i=\overline{1,M}} b_{si}} \quad (s = \overline{1,S} \text{ та } m = \overline{1,M}) \tag{5}$$

Then we will have a normalized cumulative matrix:

$$\tilde{\mathbf{R}}_M = [\tilde{b}_{sm}]_{S \times M} \tag{6}$$

in which, as a result of normalization according to (5), each row contains at least one unit.

Let us consider the product of matrices (3) and (6)

$$\mathbf{H} = \tilde{\mathbf{C}}_R \cdot \tilde{\mathbf{R}}_M \tag{7}$$

where:

$$\mathbf{H} = [h_{nm}]_{N \times M} \tag{8}$$

If, for example, we sum up all the elements of the first column of the matrix (8) and divide it by the sum of all the elements of this matrix, we will get a number that will indicate the power (efficiency) of the first tool in neutralizing all risks for a given list of conditions. Thus, after the conversion:

$$\tilde{h}_m = \frac{\sum_{k=1}^{N} h_{km}}{\sum_{k=1}^{N}\sum_{i=1}^{M} h_{ki}} \quad (m = \overline{1,M}) \tag{9}$$

Next, we find the set I_T of such indices m^*, for which

$$\tilde{h}_{m^*} > p_1 \tag{10}$$

where p_1 is an indicator of the threshold (weak) effectiveness of the tool (technology) for risk neutralization [10], [4]. Let us consider that if $\tilde{h}_{m^*} > p_1$, then m^*-th the tool lacks effectiveness, and its utilization is not cost-effective. Using this or an alternative tool always incurs non-zero costs, making it impractical to use the tool or technology casually [2], [8]. Therefore, the mentioned set:

$$I_T = \{m^* : \tilde{h}_{m^*} > p_1\} \subset \{\overline{1,M}\} \tag{11}$$

Now we get a realistic tool efficiency vector:

$$\mathbf{P} = \left[p_{m^*}\right]_{1 \times |I_T|} \tag{12}$$

in which p_{m^*} is the calculated efficiency of m^*-th tool, and $|I_T|$ is the number of effective tools, moreover:

$$p_{m^*} = \frac{\tilde{h}_{m^*}}{\sum_{i^* \in I_T} \tilde{h}_{i^*}} \quad \text{for all } m^* \in I_T \tag{13}$$

in addition:

$$p_{m^*} \in (0;\ 1) \text{ for all } m^* \in I_T \tag{14}$$

It is obvious that indicators (14) are probabilistic in nature. That is, they are equivalent to probabilities, which should be perceived as normalized proportions of comparable instruments [8], [10].

Having a realistic tool efficiency vector (12), the enterprise uses these tools according to, in fact, fractions (14). Such implementation of modern management technologies in EESS will take place during the period in which the assessment matrices (1) and (4) will be stable (valid, reliable) [2], [8]. In order to obtain matrices (1) and (4), we will involve *L* experts, each of whom will provide his own matrix:

$$C_R(l) = [a_{ns}(l)]_{N \times S} \text{ for all } l = \overline{1,L} \tag{15}$$

та:

$$R_M(l) = [b_{sm}(l)]_{S \times M} \text{ for all } l = \overline{1,L} \tag{16}$$

where $a_{ns}(l)$ is a judgment of a l-th expert about an impact of a s-th type of risk on n-th condition, and $b_{sm}(l)$ is a judgment l-th expert about an impact of m-th tool or technology for elimination (neutralization) s-th type of risk. Theoretically, one expert should provide in total $N \cdot S + S \cdot M = = S \cdot (N + M)$ evaluations of their judgments. This can be quite a large number, because for 5 conditions, 10 risks and 25 tools, we will have 10·(5+25)=300 evaluations of judgments. Therefore, we will introduce the following two conceptual restrictions here:

1) the expert's judgments should be in a binary (i.e. simplified) form - if the expert believes that the influence basically exists (the tool is really effective), then he sets 1, otherwise - he sets nothing (the matrix is automatically filled with zeros in those places where the expert did not provide judgments);

2) the number of judgments of one expert on each row of the matrix (15) does not exceed a predetermined number, that is, for each condition of the enterprise's functioning, the expert can provide no more than a certain number of judgments, which must be significantly less than the number of risks (for example, twice); similarly, the number of judgments of one expert on each line of the matrix (16) does not exceed a predetermined number, that is, for each risk, the expert can provide no more than a certain number of judgments, which should be significantly less than the number of instruments (for example, approximately three times).

Thus, accepting the stated restrictions, the following conditions will be met for each expert:

$$a_{ns}(l) \in \{0, 1\} \text{ and } b_{sm}(l) \in \{0, 1\} \quad (17)$$

Besides:

$$\sum_{s=1}^{S} a_{ns}(l) \le S_{\max} \ (n = \overline{1, N}) \quad (18)$$

and:

$$\sum_{m=1}^{M} b_{sm}(l) \le M_{\max} \ (s = \overline{1, S}) \quad (19)$$

where $S_{\max}$ is the maximum number of judgments of the l-th expert on each condition of the enterprise's functioning in the matrix $C_R(l)$, and $M_{\max}$ is the maximum number of their judgments for each risk in the matrix $R_M(l)$.

Matrices (1) and (4) are formed as follows:

$$a_{ns} = \sum_{l=1}^{L} a_{ns}(l) \ (n = \overline{1, N} \text{ та } s = \overline{1, S}) \quad (20)$$

and:

$$b_{sm} = \sum_{l=1}^{L} b_{sm}(l) \ (s = \overline{1, S} \text{ та } m = \overline{1, M}) \quad (21)$$

3. Results

The testing at the SLC «Khmelnitskhezelezobeton» enterprise involved 35 experts from among the management and production staff. SLC «Khmelnitskhezelezobeton» is a large enterprise in the construction business, so all involved experts were highly qualified and had extensive work experience. The survey was conducted at the end of August 2022, which corresponds to the period of the warm season, with the aim of determining the best combination of tools and technologies for the period of September 2022.

Cumulative matrix $\mathbf{C}_R$ for SLC «Khmelnitskhezelezobeton», shown in Table 1, is sufficiently heterogeneous.

Table 1. Cumulative matrix $\mathbf{C}_R$ for SLC «Khmelnitskhezelezobeton» for the period of warm season (August 2022)

	Risks (by list numbers given in the Introduction)									
	1	2	3	4	5	6	7	8	9	10
Seasonality	13	9	0	1	1	4	0	1	0	2
Resource support	1	10	0	1	1	7	0	0	1	1
Institutional restrictions	3	1	1	8	0	5	0	2	4	0
Market conditions	4	0	16	6	1	10	5	1	1	9
Socio-economic situation	3	9	1	3	5	9	1	0	1	9

Table 1 contains zeros in each row, indicating the absence of influence of the corresponding risks on the corresponding conditions. In particular, the lack of employees with appropriate qualifications and the decrease in the level of safety culture at the enterprise have no effect on the conditions of seasonality and resource provision. On the other hand, the market situation can have negative consequences due to the lack of workers with appropriate qualifications. Of course, the drop in demand is strongly linked to seasonality. In the normalized cumulative matrix $\tilde{\mathbf{C}}_R$ (Table 2), based on using the units in the rows, it can be seen which risks each of the five conditions is most strongly associated with.

Table 2. Normalized cumulative matrix $\tilde{\mathbf{C}}_R$ for SLC «Khmelnitskhezelezobeton» for the period of warm season (August 2022)

	Risks (by list numbers given in the Introduction)									
	1	2	3	4	5	6	7	8	9	10
Seasonality	1	0,692	0	0,076	0,076	0,307	0	0,076	0	0,153
Resource support	0,1	1	0	0,1	0,1	0,7	0	0	0,1	0,1
Institutional restrictions	0,375	0,125	0,125	1	0	0,625	0	0,25	0,5	0
Market conditions	0,25	0	1	0,375	0,062	0,625	0,312	0,062	0,062	0,562
Socio-economic situation	0,333	1	0,111	0,333	0,555	1	0,111	0	0,111	1

Cumulative matrix $\mathbf{R}_M$ for SLC «Khmelnitskhezelezobeton» is shown in Table 3. Here, too, there is a significant spread of the sums of integer estimates of 35 experts. It is interesting that of the 250 elements of this matrix, 93 are zeros, and the number of units is 110. Analysis of the units of the normalized cumulative matrix $\tilde{\mathbf{R}}_M$ (Table 4) shows that only the complexity reduction technology (#7) has the greatest effectiveness in eliminating more than one type of risk.

Table 3. Cumulative matrix $\mathbf{R}_M$ for SLC «Khmelnitskhezelezobeton» for the period of warm season (August 2022)

		Tools and Technologies (by list numbers listed in the Introduction)																								
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
Risks (by the numbers given in the Introduction)	1	3	1	1	13	4	0	0	1	2	0	8	7	1	1	0	1	0	0	6	0	1	1	0	0	1
	2	1	2	1	0	0	1	5	0	1	0	1	0	1	0	0	1	0	1	3	0	0	1	0	1	0
	3	0	2	0	0	1	1	1	3	0	1	0	0	10	9	8	3	1	12	1	0	0	1	1	1	1
	4	5	2	5	1	3	1	1	1	0	0	0	1	3	0	1	5	1	0	1	0	1	0	0	0	6
	5	0	0	0	1	0	1	0	1	0	0	0	1	0	1	8	0	0	1	0	1	1	0	1	5	0
	6	0	1	1	3	0	0	5	1	1	1	1	6	0	1	1	1	0	1	0	0	1	0	1	0	0
	7	1	0	0	0	1	3	1	0	1	1	1	1	6	0	1	0	12	1	1	1	1	0	0	1	0
	8	3	4	1	1	1	5	0	1	1	1	0	0	4	8	1	3	1	2	1	1	1	0	0	0	0
	9	0	1	1	1	6	0	2	1	2	1	4	0	0	0	1	1	0	2	1	1	1	0	1	1	1
	10	1	1	1	1	0	1	12	0	1	1	0	1	6	1	0	0	0	1	0	2	0	1	1	1	1

Table 4. Normalized cumulative matrix $\tilde{\mathbf{R}}_M$ for SLC «Khmelnitskhezelezobeton» for the period of warm season (August 2022)

		Tools and Technologies (by list numbers listed in the Introduction)																								
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
Risks (by the numbers given in the Introduction)	1	0,23	0,076	0,076	1	0,307	0	0	0,076	0,153	0	0,615	0,538	0,076	0,076	0	0,076	0	0	0,461	0	0,076	0,076	0	0	0,076
	2	0,2	0,4	0,2	0	0	0,2	1	0	0,2	0	0,2	0	0,2	0	0	0,2	0	0,2	0,6	0	0	0,2	0	0,2	0
	3	0	0,166	0	0	0,083	0,083	0,083	0,25	0	0,083	0	0	0,833	0,75	0,666	0,25	0,083	1	0,083	0	0	0,083	0,083	0,083	0,083
	4	0,833	0,333	0,833	0,166	0,5	0,166	0,166	0,166	0	0	0	0,166	0,5	0	0,166	0,833	0,166	0	0,166	0	0,166	0	0	0	1
	5	0	0	0	0,125	0	0,125	0	0,125	0	0	0	0,125	0	0,125	1	0	0	0,125	0	0,125	0,125	0	0,125	0,625	0
	6	0	0,166	0,166	0,5	0	0	0,833	0,166	0,166	0,166	0,166	1	0	0,166	0,166	0,166	0	0,166	0	0	0,166	0	0,166	0	0
	7	0,083	0	0	0	0,083	0,25	0,083	0	0,083	0,083	0,083	0,083	0,5	0	0,083	0	1	0,083	0,083	0,083	0,083	0	0	0,083	0
	8	0,375	0,5	0,125	0,125	0,125	0,625	0	0,125	0,125	0,125	0	0	0,5	1	0,125	0,375	0,125	0,25	0,125	0,125	0,125	0	0	0	0
	9	0	0,166	0,166	0,166	1	0	0,333	0,166	0,333	0,166	0,666	0	0	0	0,166	0,166	0	0,333	0,166	0,166	0,166	0	0,166	0,166	0,166
	10	0,083	0,083	0,083	0,083	0	0,083	1	0	0,083	0,083	0	0,083	0,5	0,083	0	0	0	0,083	0	0,166	0	0,083	0,083	0,083	0,083

The result of the matrix product in the Table 2 and 4 is shown in Table 5. Nominal vector of efficiency of tools $\tilde{\mathbf{H}}$, 25 elements of which are calculated according to formula (9), i.e. as:

$$\tilde{h}_m = \frac{\sum_{k=1}^{10} h_{km}}{\sum_{k=1}^{10}\sum_{i=1}^{25} h_{ki}} \quad (m=\overline{1,25}) \qquad (22)$$

is shown in the Table 6. For SLC «Khmelnitskhezelezobeton» the threshold (weak) efficiency indicator of the tool (technology) for risk neutralization was taken as $p_1 = 0{,}05$. Therefore, the set of indices m^*, for which $\tilde{h}_{m^*} > 0{,}05$ is the following:

$I_T = \{4, 7, 12, 13, 16\}$.

Table 5. Matrix $\mathbf{H} = [h_{nm}]_{5\times25}$, *calculated as (7), for SLC «Khmelnitskhezelezobeton» for the period of warm season (August 2022)*

Conditions (according to the numbers given in the Introduction)		Tools and Technologies (according to the list numbers given in the Introduction)																								
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
	1	0,475	0,482	0,353	1,198	0,355	0,221	1,115	0,16	0,366	0,073	0,805	0,881	0,369	0,227	0,15	0,359	0,022	0,231	0,899	0,044	0,16	0,228	0,073	0,199	0,166
	2	0,314	0,582	0,432	0,504	0,18	0,237	1,733	0,17	0,373	0,141	0,444	0,791	0,307	0,145	0,25	0,424	0,016	0,37	0,679	0,045	0,17	0,216	0,154	0,287	0,132
	3	1,038	0,745	1,105	0,968	1,157	0,358	0,989	0,445	0,384	0,229	0,693	0,993	0,783	0,476	0,468	1,199	0,208	0,483	0,539	0,114	0,414	0,064	0,197	0,118	1,122
	4	0,466	0,503	0,501	0,697	0,444	0,317	1,276	0,461	0,244	0,278	0,325	0,902	1,508	0,99	0,94	0,719	0,466	1,221	0,305	0,145	0,237	0,149	0,252	0,205	0,534
	5	0,647	0,823	0,771	1,06	0,398	0,445	2,944	0,363	0,547	0,287	0,655	1,397	1,04	0,428	0,879	0,716	0,175	0,676	0,846	0,263	0,345	0,318	0,347	0,667	0,47

Table 6. Nominal vector of efficiency of instruments $\tilde{\mathbf{H}} = [\tilde{h}_m]_{1\times25}$ *for SLC «Khmelnitskhezelezobeton» for the period of warm season (August 2022)*

Tools and Technologies (according to the list numbers given in the Introduction)																								
1	2	3	**4**	5	6	**7**	8	9	10	11	**12**	**13**	14	15	**16**	17	18	19	20	21	22	23	24	25
0,044	0,047	0,048	**0,067**	0,038	0,024	**0,122**	0,024	0,029	0,015	0,044	**0,075**	**0,061**	0,034	0,04	**0,052**	0,013	0,045	0,049	0,009	0,02	0,014	0,015	0,022	0,036

The corresponding columns are highlighted in the Table 6. Therefore, for SLC «Khmelnitskhezelezobeton» for the period of September 2022, the realistic tool efficiency vector **P**, calculated by formula (13) as following:

$$p_{m^*} = \frac{\tilde{h}_{m^*}}{\tilde{h}_4 + \tilde{h}_7 + \tilde{h}_{12} + \tilde{h}_{13} + \tilde{h}_{16}} \text{ for all:}$$

$m^* \in \{4, 7, 12, 13, 16\}$,

consists of five tools and technologies: benchmarking, complexity reduction, customer segmentation, digital transformation, and mergers and acquisitions. This vector is shown in Table 9, where, certainly: $p_4 + p_7 + p_{12} + p_{13} + p_{16} = 1$.

Table 7. Realistic tools efficiency vector $P = [p_{m^*}]_{1\times5}$ *for SLC «Khmelnitskhezelezobeton» for the period of warm season (August 2022)*

	Tools and technologies (according to the list numbers given in the introduction)				
m^*	4	7	12	13	16
p_{m^*}	0,178	0,323	0,199	0,161	0,137

Vector *P* in Table 7 is both an evaluation "report" for August and an indicator of how to combine the use of tools and modern management technologies in EESS of SLC «Khmelnitskhezelezobeton» during September 2022 (of course, provided that no global changes are expected during September that is, the macroeconomic situation will remain at the same level of the ratio of stability and instability).

4. Conclusions

In the event, the technology of reducing complexity should be dominant in the support of EESS of SLC «Khmelnitskhezelezobeton». About a third of all resources used to support EESS should go specifically to reducing complexity. The rest of the technologies have about the same weight. The impact of digital transformation, which is a consequence of adaptation to new conditions of the digital economy and digitalization in general, should be noted separately.

It is expected that a new evaluation of the matrices 2022 $\mathbf{C}_R$ and $\mathbf{R}_M$ will be carried out at the end of September (now, actually, for September) similarly to the Table 1 and table 3. It is quite possible that the application result for the model of the introduction of modern management technologies in EESS of SLC «Khmelnitskhezelezobeton» will again be a list of the same five tools and technologies, but with a slightly different efficiency vector. In general, the value of the research for enterprises in the construction industry lies in the improvement of management system and ensuring their economic security through the use of exactly those management tools that are able to create the maximum effect in accordance with the existing features of business functioning. Prospects for further research lie in the search for universal approaches that would allow leveling the influence of specific circumstances and conditions.

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