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THE ENTERPRISE ECONOMIC SECURITY SYSTEM: THE STATE ASSESSMENT USING MANAGEMENT FUNCTIONAL TYPES

Abstract:*The use of the model of the state assessment of an enterprise economic security system allows to get a general assessment of the system state and its balance by type of management (strategic, operational, financial, innovation, personnel, marketing). In contrast to the existing models, this one allows to distinguish between the most important types of management influence and to operate with factors that determine the level of their development in the future. In addition, the proposed model allows to assess the balance of an enterprise economic security system and identify its imperfections within a specific type of management.*

Keywords: *Enterprise; Economic security; System; Management.*

1. Introduction

To control the management of any object, it is extremely important to determine the state of the research object in order to develop and to implement further the impact measures to transfer the system to a qualitatively different state. An enterprise economic security system is not an exception, as it is also recognized as an object of management. Therefore, an important task of enterprise management is the assessment of the state of an enterprise economic security system. This is due to the fact that the decision-making takes place in accordance with the actual and potential risks and threats of the enterprise's activity (observance of the safety criterion), the profitable activity of the enterprise taking into account the negative influence of environments is being ensured (observance of the profitability criterion) and finding the optimal correlation between the security state and the activity profit is being implemented (balance) when determining the managerial influence within such management object as enterprise economic security (Havlovska et al., 2019).

2. Literature review

Available numerous approaches to assessing the state of the system of economic security of an enterprise are based on the definition of a specific integral indicator. On the one hand, this makes it possible to briefly describe the current position of the system (although the parameters gradation of the state of the system and their interpretation are often quite subjective). However, on the other hand, such a formalized approach with obtaining a single quantitative assessment is not very suitable, since it does not allow specifying the places of the main problems and promptly respond with appropriate management decisions. The realities of the practical activities of most domestic enterprises need both generalized approaches and abstract proposals, which are developed on the basis of the integral index obtained (by different methods), and also effective

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concrete measures that are understandable for the majority of participants in the management process. Accordingly, the specifics of the functioning of the economic security system of an enterprise and, in some cases, the formalization of its state indicators is complicated, which makes it expedient to use analytical evaluation methods, taking into account the orientation to the management needs. When assessing the state of an enterprise economic security system, it is necessary to consider the relevant indicators. But the choice of indicators that act as an assessment of the state of the enterprise economic security system should be preceded by a choice of assessment approach. The most common assessment in economic security science is the indicator approach, the resource-functional approach, program-oriented (integrated) approaches, an approach based on the theory of economic risks and game theory. As a separate tool for such an assessment, analytical models based on the assessment of the probability of bankruptcy are used.

The indicator approach is based on determining the state of economic security with the help of indicators, which are understood as the limit values of indicators characterizing the activities of economic entities in various functional areas and corresponding to a certain level of their economic security (Bendikov, 2000; Illarionov, 1998).

The resource-functional approach is based on assessing the state of use of corporate resources (capital, personnel, information and technology, machinery and equipment, legal rights and other intangible assets). The level of business entities economic security is determined by the use of an integral indicator calculated on the basis of partial functional indicators using an expert survey (Donets & Vashchenko, 2008; Eitutis, 2009).

The program-target approach is based on the integration of indicators that determine the level of economic security of an enterprise (Bogutska, 2018). Significant limitations of the program-target approach include: complexity of implementation; considerable attention should be given to the selection of indicators and the identification of their integration methods. Estimation in economic security science based on the theory of economic risks, which is based on determining the probability of risky events occurrence. (Brustbauer, 2016; Carroll, 2016; Choi et al., 2016; Zlotenko et al., 2019; Polozova et al., 2019).

Estimation in economic security science on the basis of game theory allows determining the point (points) of maximum balancing of the interests of each participant (in the form of extremes of the amounts of assessments of the interests of each game participant) (Rudnichenko et al., 2019; Varela-Vaca, Gasca, 2015; Yu et al., 2014).

The approaches based on the assessment of the probability of bankruptcy include(Aleksanyan & Huiban, 2016; Horváthová & Mokrišová, 2018; Rudnichenko et al., 2018; Tereschenko, 2006): discriminatory models of Altman, Chesser, Taffler, Lees, Connan, Golder, Tereshchenko, based on the construction of a multifactorial discriminatory model as the main safety indicator;methods based on the determination of average values are based on the determination of the financial and economic condition of economic entities are depending on the value of the weighted average deviation of the actual values of indicators of liquidity, solvency and financial stability from their normative values;the Beaver model provides for estimating the probability of bankruptcy of an enterprise depending on the value of five key financial economic indicators: Beaver’s ratio; current liquidity ratio; return on assets; financial leverage; the ratio of working capital to current assets;the coefficient of financing of illiquid assets - the solvency of the company is determined basing on the degree of provision of illiquid assets (non-current assets and stocks) by own and borrowed sources of financing. The model reflects the asset financing policy maintained by the enterprise (conservative, moderate, aggressive or too aggressive).

Despite the clearly incomplete studies of approaches to evaluation in economic security science, the content of these approaches, their advantages and limitations have already received a fairly detailed description (for example:Havlovskaet al., 2019;Kozachenko et al., 2019; Rudnichenko et al., 2018).

Therefore, taking into account the advantages and limitations of existing approaches to evaluation in economic security science, preference is given to the functional approach, that is, the assessment of the system state by the functional types of enterprise management. This choice is due to the following: assessment of the system state by type of enterprise management allows you to localize its problem areas and focus the management mechanism on the identified "bottlenecks".

3. Methodology

The indicators for assessing the state of the enterprise economic security system are provided in Table 1.

Table 1. The indicators for assessing the state of the enterprise economic security system

Management type	Indicator
Strategic management	Achievement of strategic goals in the context of the formation of an enterprise economic security system: achieved, achieved with a valid excess of time, not achieved
	Protection expenses indicator: 0 to 1
	The expenses share for the enterprise protection in the overall structure of production costs: *Cex.prot.*≥ 0,17 – high security level; 0,12 ≤ *Cex.prot.*< 0,17 – medium security level; *Cex.prot.*< 0,12 – low security level
	Legal security indicator: 0 to 1
	Coefficient of unlawful control over the enterprise: 0-0,2 – sufficient; 0,21-0,5 – sufficient with the attempts to establish control; 0,51-0,8 – the absence of any real attempts to establish control; 0.81-1 – lack of real intentions
Operational management	Coefficient of fixed assets depreciation: < 0,5
	Coefficient of the production program performance: ≤ 1
	Coefficient of raw material security: ≥ 1
	Coefficient of energy security: ≥ 1
	Indicator of enterprise dependence on suppliers of raw materials and materials: min
Financial management	Financial strength reserve: max
	Coefficient of total coverage: 2 - critical value; 2-2,5 - the company liquidates its debts on time
	Coefficient of break-even: min
	Return on assets: > average industry indicator
	Coefficient of independence: > 0,6
Innovation management	Share of research and engineering work: ≤ 1
	Intellectual armament: *Cia* > 19,75 – absolute security; 19,75≥ *Cia*> 14,5 – satisfactory security; 14,5 ≥ *Cia*> 9,25 – unsatisfactory security; *Cia*≤ 9,25 – critical security
	Coefficient of introduction of innovative types of products: *Cin.p.*≥ 0,272 – absolute security; 0,183≤ *Cin.p.*< 0,272 – satisfactory security; 0,094 ≤ *Cin.p.*< 0,183 – unsatisfactory security; *Cin.p.*< 0,094 – critical security
	Share of innovation expenditures that are used in the production, management and service process: Cin.ex.≥ 0,138 – absolute security; 0,09 ≤ *Cin.ex.*< 0,138 – satisfactory security; 0,044 ≤ *Cin.ext.*< 0,09 – unsatisfactory security; *Cin.ex.*< 0,044 – critical security
	Level of technology progressiveness: 0 – minimal; 0.35 – average; 0.7 or more – maximum

Table 1. The indicators for assessing the state of the enterprise economic security system(continued)

Management type	Indicator
Investment management	Level of enterprise economic security: under 0.05 - supporting; 0.06-0.1 – minimum; 0,11-0,19 – very low; 0,2-0,29 – low; 0,3-0,49 – average; 0.5-07 – high; higher than 0.7 – very high
Personnel management	Coefficient of growth rate of revenue and payroll: ≥ 1
	Coefficient of work experience (share of staff with work experience of more than 2 years totally): ≥ 0,9
	Coefficient of stuff aging: 0,2 ≤*Cag*<0,255 – absolute security; 0,255 ≤*Cag* < 0,311 – satisfactory security; 0,311 ≤*Cag* < 0,367 – unsatisfactory security; 0,367 ≤*Cag* < 0,423 – critical security
Marketing management	Indicator of enterprise competitive advantage: =1 (± 0,1)
	Indicator of compliance with the quality of manufactured products: ≤ 1

These figures are quite informative in highlighting the components of enterprise management in the context of security-oriented management.

As we can see from Table 1, indicators for assessing the state of the enterprise economic security system are divided between the two horizons of management – strategic and operational.

The chosen approach to assessing the state of an enterprise economic security system should be supported by appropriate tools. An economic mathematical model for assessing the economic security of an enterprise is proposed as an instrument. The description of the model is as follows.

Let $\{m_k\}_{k=1}^{7}$ be a combination of seven types of management, which forms an enterprise economic security system (m_1– strategic; m_2 – operational; m_3 – financial; m_4 – innovative; m_5 – investment; m_6 – personnel; m_7 – marketing management The state of management of an enterprise economic security system for each type of management is described by certain indicators (Table 1). These indicators are numbered according to the sequence in which they are mentioned in Table 1.

Thus, management m_k has indicators $\left\{g_k^{\langle i_k \rangle}\right\}_{i_k=1}^{I_k}$, where:

$$I_1 = 5,\ I_2 = 5,\ I_3 = 5,\ I_4 = 5,\ I_5 = 2,\ I_6 = 5,\ I_7 = 4. \qquad (1)$$

Of course, it is necessary to normalize the values of indicators before assessment the state of an enterprise economic security system. This can be done by shifting to a single segment [0; 1]:

$$\tilde{g}_k^{\langle i_k \rangle} = \frac{g_k^{\langle i_k \rangle} - \min\limits_{j_k = 1,\, I_k} g_k^{\langle j_k \rangle}}{\max\limits_{j_k = 1,\, I_k} g_k^{\langle j_k \rangle} - \min\limits_{j_k = 1,\, I_k} g_k^{\langle j_k \rangle}}$$

with $k = \overline{1,\, 7}$. (2)

In the future, we will process these normalized metrics (2), since the possible zero (lowest) values of the indicators are more convenient in the calculations.

Before carrying out a quantitative (cardinal) assessment of the indicator $g_k^{\langle i_k \rangle}$, it is necessary to rank its possible values (intervals)$\left\{g_k^{\langle i_k \rangle}(u)\right\}_{u=1}^{U_{i_k}}$, where U_{i_k} is the finite number of these possible values. This will allow experts to offer a quantitative assessment of the ratio of benefits (unevenness) between the possible values of this indicator later. We use the matrix ranking as the most objective one (Dinu & Manea, 2006). Matrix ranking is the most objective type of expertise due to the fact that it performs the streamlining procedure (Dinu & Manea, 2006). The matrix ranking of an individual expert may contain cycles (Baets et al., 2010; Dinu & Manea, 2006), from which a generalized order cannot be obtained (strict or non-uniform, with equivalence). In addition, the matrix ranking allows a small number of experts, which is important for the speed of processing expert data.

Let $\mathbf{F}_h = \left[a_{qr}^{\langle h \rangle} \right]_{U_{i_k} \times U_{i_k}}$ be matrix ranking of s-th expert on possible values (intervals) $\left\{ g_k^{\langle i_k \rangle}(u) \right\}_{u=1}^{U_{i_k}}$, where $h = \overline{1, H}$ and $H \in \mathbb{N} \setminus \{1\}$ is total number of experts. Such properties of matrices $\left\{ \mathbf{F}_h \right\}_{h=1}^{H}$ are known:

$$a_{qq}^{\langle h \rangle} = 0 \;\forall\; q = \overline{1, U_{i_k}} \text{ and } a_{qr}^{\langle h \rangle} = \pm 1$$

$$\text{with } a_{qr}^{\langle h \rangle} = -a_{rq}^{\langle h \rangle}, \tag{3}$$

that is, such a ranking is a skew-symmetric matrix (Fania & Mezzetti, 2011), the main property of which is equality $\mathbf{F}_h = -\mathbf{F}_h^{\mathrm{T}}$. Statistical approach for data processing of expert rankings $\left\{ \mathbf{F}_h \right\}_{h=1}^{H}$ is as follows. If the average weighted value

$$p_{qr} = \frac{1}{H} \sum_{h=1}^{H} \lambda_h a_{qr}^{\langle h \rangle} \text{ with } q = \overline{1, U_{i_k}} \text{ and } r = \overline{1, U_{i_k}} \tag{4}$$

is integral, then the value (4) is interpreted as the statistical probability of *q*-th variant of value indicator $g_k^{\langle i_k \rangle}$ are more influential and more significant for its consideration in the form of management m_k than *r*-th variant (Dinu & Manea, 2006). Proceeding from this, we shall further solve the equation:

$$p_{qr} = \frac{1}{\sqrt{2\pi}} \int_{-\infty}^{g_{qr}} e^{-\frac{\vartheta^2}{2}} d\vartheta \text{ with } q = \overline{1, U_{i_k}} \text{ and } r = \overline{1, U_{i_k}} \tag{5}$$

relatively to the value g_{qr}. After defining from the equations of type (5) the value of $\left\{ \left\{ g_{qr} \right\}_{q=1}^{U_{i_k}} \right\}_{r=1}^{U_{i_k}}$, we find their averaging in this way:

$$g_q = \frac{1}{U_{i_k}} \sum_{r=1}^{U_{i_k}} g_{qr} \;\forall\; q = \overline{1, U_{i_k}}. \tag{6}$$

Average value $\left\{ g_q \right\}_{q=1}^{U_{i_k}}$ in (6) are preliminary estimates of each of U_{ik} variant of value $g_k^{\langle i_k \rangle}$. In the case of inconsistencies in expert evaluations, these assessments should be reviewed, that is, at least one more expert procedure will be conducted. So, before accepting these assessments $\left\{ g_q \right\}_{q=1}^{U_{i_k}}$, calculated using (6), they perform an expert assessment of consistency. To do this, first, they determine the values $\bar{g}_{qr} = \frac{1}{\sqrt{2\pi}} \int_{-\infty}^{g_q - g_r} e^{-\frac{\vartheta^2}{2}} d\vartheta$ with $q = \overline{1, U_{i_k}}$ and $r = \overline{1, U_{i_k}}$.

Then all deviations are calculated $\delta_{qr} = \left| g_{qr} - \bar{g}_{qr} \right|$ with $q = \overline{1, U_{i_k}}$ and $r = \overline{1, U_{i_k}}$. The average deviation is calculated taking into account the symmetry $\delta_{qr} = \delta_{rq}$:

$$\delta = \frac{1}{2 \cdot U_{i_k} \cdot \left(U_{i_k} - 1 \right)} \sum_{r=1}^{U_{i_k}} \sum_{q=r+1}^{U_{i_k}} \delta_{qr}.$$

If the condition:

$$\delta < \delta_{\max} \tag{7}$$

is fulfilled for some predetermined $\delta_{\max}$, then expert assessments are considered to be consistent. After that, you can already operate the estimates $\left\{ g_q \right\}_{q=1}^{U_{i_k}}$ in (6). They should be normalized. So, normalized assessment of *q*-th variant of value $g_k^{\langle i_k \rangle}$ will be the following: $g_q^* = \frac{g_q}{\sum_{r=1}^{U_{i_k}} g_r}$ with $q = \overline{1, U_{i_k}}$.

Now assessments:

$$v\left(\tilde{g}_k^{\langle i_k\rangle}(u)\right)=g_u^* \ \forall \ u=\overline{1, U_{i_k}} \qquad (8)$$

are dimensionless and convenient for further work (under condition of the agreement of expert assessments).

The value $\left\{v\left(\tilde{g}_k^{\langle i_k\rangle}(u)\right)\right\}_{u=1}^{U_{i_k}}$ with (8) are in fact the weight corresponding to the value $\left\{\tilde{g}_k^{\langle i_k\rangle}(u)\right\}_{u=1}^{U_{i_k}}$. Therefore, a point assessment of the indicator $\tilde{g}_k^{\langle i_k\rangle}$ of m_k type of management will be defined as a convolution (convex convolution) of values $\left\{\tilde{g}_k^{\langle i_k\rangle}(u)\right\}_{u=1}^{U_{i_k}}$ with weight $\left\{v\left(\tilde{g}_k^{\langle i_k\rangle}(u)\right)\right\}_{u=1}^{U_{i_k}}$ with (8):

$$v\left(\tilde{g}_k^{\langle i_k\rangle}(u_1^*)\right)=\sum_{u=1}^{U_{i_k}} v\left(\tilde{g}_k^{\langle i_k\rangle}(u)\right)\cdot \tilde{g}_k^{\langle i_k\rangle}(u)$$

with $i_k=\overline{1, I_k}$ and $k=\overline{1, 7}$. (9)

It's obvious that

$v\left(\tilde{g}_k^{\langle i_k\rangle}(u_1^*)\right)\in[0;1]$ with $i_k=\overline{1, I_k}$ and $k=\overline{1, 7}$. (10)

Further, with found and optimized (estimated) values of indicators (9) for all types of management, we can assess the state of an enterprise economic security system as a whole and for each type of management separately. For the type of management m_k such (local) assessment is defined as follows:

$$s_k=\sum_{i_k=1}^{I_k}\alpha(i_k)\cdot v\left(\tilde{g}_k^{\langle i_k\rangle}(u_1^*)\right) \text{ with } k=\overline{1, 7}, \qquad (11)$$

with $\alpha(i_k)$ is the weight $\alpha(i_k)$ of indicator $\tilde{g}_k^{\langle i_k\rangle}$.

Of course, these weight have the following properties: $\alpha(i_k)\in(0;1)$ with $i_k=\overline{1, I_k}$ and $k=\overline{1, 7}$, where: $\sum_{i_k=1}^{I_k}\alpha(i_k)=1$.

The weight $\{\alpha(i_k)\}_{i_k=1}^{I_k}$ will be determined in an expert way similar to determining the values $\left\{v\left(\tilde{g}_k^{\langle i_k\rangle}(u)\right)\right\}_{u=1}^{U_{i_k}}$ using (8), using matrix ranking. In this case, the algebraic processing using the Kemeny median can be skipped.

Of course, local estimates of management types according to (11) are normalized within a single interval, that is:

$s_k\in(0;1)$ with $k=\overline{1, 7}$. (12)

As we see from (12), the zero value is impossible, as well as "1". After determining these local estimates of management types using (11), we determine the overall assessment of the enterprise economic security system. This is done using the same convex convolution with weights $\{\mu_k\}_{k=1}^{7}$:

$$S_{SESE}=\sum_{k=1}^{7}\mu_k\cdot s_k, \qquad (13)$$

where the weight of the management type m_k is: $\mu_k\in(0;1)$ with $k=\overline{1, 7}$, where $\sum_{k=1}^{7}\mu_k=1$.

4. Results

To confirm the validity of the developed model for assessing the state an enterprise economic security system, its testing was carried out on the example of three enterprises that are average (by number of employees) and operate in competitive markets: PC "Machine-building enterprise "Komsomolets", LLC "Karlivsky machine-building enterprise" and LLC "Elba": the first two enterprises produce machinery and equipment for agriculture, were created for a long time ago. LLC "Elba" is a young enterprise (was founded in 2002), produces auto and household chemicals. It is impossible to argue that a complete system of economic security has been created at these enterprises, but the work in this direction is being carried out. At least, the management of the company is aware of the need for such a system. Although, because these enterprises already have officials who are responsible for ensuring economic security, and individual elements of the system that still need to be combined on a systemic basis. The developed model for assessing the state of an enterprise economic security system, seven types of management were considered and the data of the analyzed enterprises for 2018 were used in approbation. The value of each indicator from among those proposed for use (Table 1) was calculated using the design diagrams provided in Table 2.

Table 2. Calculation diagrams of indicators of the state of an enterprise economic security system

Indicator	Calculation diagram
Achievement of strategic goals in the context of the formation of an enterprise economic security system	Expert survey
Protection expenses indicator	*Ip.ex.= Inc.prot/ Inc.t* where *Inc.prot* – the income that the company spends to protect activities from the negative impact of the state; *Inc.t* – total income
Share of expenses for an enterprise protection	*Cex.prot. = Ex.prot/Ex.t* where *Ex.prot* – protection expenses; *Ex.t* – total expenses
Legal security indicator	$Lsi = \sum Evln / \sum Ep$ where *Evln* – total amount of enterprise losses from violation of legal norms; *Ep* – total loss prevented by legal service
Coefficient of unlawful control over the enterprise	Expert survey
Coefficient of fixed assets depreciation	$C_d = A_d / B_v$ where A_d – amount of fixed assets depreciation; B_v – balanse value of fixed assets
Coefficient of production program performance	*Cp.f. = Nact / Nplan* where *Nact* – actual production of products in kind; *Nplan* – planned production of products in natural terms
Coefficient of raw material security	$Cmc = \frac{\sum_{i=1}^{n} Exm_i \times (Rm_i \times Pm_i)}{\sum_{i=1}^{n} Exm_i}$ where Exm_i – the specific weight of expenses for the *i*-th type of raw material resources in the total amount of expenses of the enterprise on raw materials in value terms; Rm_i– rate of change of specific consumption of the *i*-th type of raw material resource in physical terms; Pm_i– price index for the *i*-th type of raw material resource
Coefficient of energy security	$Cms = \frac{\sum_{i=1}^{n} Exe_i \times (Re_i \times Pe_i)}{\sum_{i=1}^{n} Exe_i}$ where Exe_i – the specific weight of expenses for the *i*-th type of energy carriers in the total amount of expenses of the enterprise on raw materials in value terms; Re_i – rate of change of specific consumption of the *i*-th type of energy carrier in physical terms; Pe_i– price index for the *i*-th type of energy carrier
Indicator of enterprise dependence on suppliers of raw materials and materials	Ide = Dmax/Dt where Dmax – maximum number of deliveries per supplier; Dt – total number of deliveries of all suppliers

Table 2. Calculation diagrams of indicators of the state of an enterprise economic security system (continued)

Indicator	Calculation diagram
Financial strength reserve	FSR = NR – Bet where NR – net revenue, Bet – break-even turnover
Coefficient of total coverage	Cc = Ca/ So where Ca – current assets; So – short-term obligations
Coefficient of break-even	*Cb = Exconst/MP* where *Exconst* – amount of constant expenses; *MP* – total marginal profit
Return on assets	$R_a = N_p/V_{aa}$, where N_p – net profit; V_{aa}– average value of assets
Coefficient of independence	*Ci = Ee/Ft* where *Ee* – enterprise equity; *Ft* – total value of economic funds
Share of research and engineering work	$Sre = REW / \sum Cw$ where *REW* – number of scientific and research work performed during the year; *Cw* – total number of completed work for the reporting year
Intellectual armament	*Cia = Cip/ O* where *Cip* – cost of intellectual property; *O* – total number of enterprise employees
Coefficient of introduction of innovative types of products	*Cin.p. = Ni.p. / Nt.p.* where*Ni.p.* – number of innovative types of products manufactured by an enterprise; *Nt.p.* – total quantity of products
Share of innovation expenditures that are used	$Cin.ex. = \sum Ex_i / \sum Ex_n$ where $\sum Ex_i$ – amount of expenses for innovation, $\sum Ex_n$ – total expenses for products production and sales
Level of technology progressiveness	Expert survey
Level of enterprise economic security	$L_{EES} = GI^t/I^t_{EES}$ where GI^t– gross investment of the enterprise in the year *t*, UAH; I^t_{EES}– enterprise investment in year t required to ensure economic security, UAH
Turnover of highly skilled workers	$Ths = \sum Eq / \sum E$ where *Eq* – employees who quit; *E* – the total number of employees of this qualification
Indicator of employees' education level	$Ie = \sum Che / \sum E$ where *Che* – number of employees, who has higher education according to the activity type; *E* – total number of employees
Coefficient of growth rate of revenue and wage fund	$Cgr = \Delta NR/\Delta P$ where ΔNR – growth rate of revenue; ΔP – growth rate of the wage fund
Coefficient of work experience	$Cex. = C_2 / Ngen$, where C_2 – share of personnel with experience of more than 2 years; *Ngen* – the total number of staff
Coefficient of stuff aging	*Ca = Oa / O* where *Oa* – number of employees who are old; *O* – total number of employees
Indicator of enterprise competitive advantage	*Iec = Sem / Sec*, where *Sem* – share of the enterprise market in the analyzed period; *Sec* – share of the nearest market competitor for the similar period
Indicator of enterprise dependence on consumers	$Idc = \sum SPOmax / \sum SPgen$ *where SPOmax – maximum quantity (volume) of sold products to one consumer during the year; SPgen – the total quantity (volume) of sold products during year*
Indicator of contractor reliability	$Ic = \sum Cd / \sum Gd$ where *Cd* – total amount of raw materials and materials, which delivery terms are violated; *Gd* – total volume of delivered resources
Indicator of compliance with the quality of manufactured products	Pq = SGr / SGgen where SGr – total volume of saled goods that were returned during the year; SGgen – the total volume of industrial products.

In approbation of the developed model of state estimation of an enterprise economic security system for the calculation of weights $\{\mu_k\}_{k=1}^{7}$ experts areinvolved (H=25), They were the experts of the company, faced with issues of economic security and have an idea of its provision at this enterprise. The scales of experts are approximately the same with enough accuracy for practice.

Approbation of the developed model is shown in detail for LLC "Karlivsky machine-building enterprise"; the resulting approbation data are provided for other enterprises.

The procedure for determining local assessments of the state of an economic security system has begun on the calculation of weights $\{\mu_k\}_{k=1}^{7}$ by the relation (13). Calculations on (4) – (6) are carried out using the obtained 30 7 × 7 matrices $\{\mathbf{F}_h\}_{h=1}^{30}$. The average matrix has the form (Figure 1). Probabilities (4) are as follows (Figure 2).

0	-1.0000	-0.8000	-1.0000	-1.0000	-1.0000	-1.0000
1.0000	0	0.9333	-1.0000	-1.0000	0.6000	-0.7333
0.8667	-1.0000	0	-1.0000	-1.0000	-0.6667	-1.0000
1.0000	1.0000	1.0000	0	-0.7333	1.0000	0.8667
1.0000	1.0000	1.0000	0.4667	0	1.0000	0.9333
1.0000	-0.5333	0.7333	-1.0000	-1.0000	0	-0.9333
1.0000	0.6667	1.0000	-0.7333	-0.9333	0.9333	0

Figure 1. The average matrix on the basis ofobtained 30 7 × 7 matrices $\{\mathbf{F}_h\}_{h=1}^{30}$ according to (4) - (6)for"Karlivsky machine-building enterprise"

0	0	0	0	0	0	0
1.0000	0	0.9333	0	0	0.6000	0
0.8667	0	0	0	0	0	0
1.0000	1.0000	1.0000	0	0	1.0000	0.8667
1.0000	1.0000	1.0000	0.4667	0	1.0000	0.9333
1.0000	0	0.7333	0	0	0	0
1.0000	0.6667	1.0000	0	0	0.9333	0

Figure 2. Probabilities (4) for "Karlivsky machine-building enterprise"

To calculate the values (6), the solutions of equation (5), which are infinity (for cases $p_{qr}=1$), are taken equal to 10. Zero probabilities are compared with small positive numbers (~ 0.1). As the result we have the following values (6):

$$\begin{Bmatrix} 0.1, 11.8919, 1.0614, 41.0614, 41.7372, \\ 10.7854, 21.9808 \end{Bmatrix}$$

As it turned out on condition (7), the opinions of the experts are consistent. Therefore, in accordance with (8) we obtain:

$$\mu_1 = 0.0008, \mu_2 = 0.0925, \mu_3 = 0.0083, \mu_4 = 0.3193,$$
$$\mu_5 = 0.3245, \mu_6 = 0.0839, \mu_7 = 0.1709.$$

Local assessments (11) are estimated similarly. For strategic management, the averaged matrix according to $\{\mathbf{F}_h\}_{h=1}^{30}$, probability (4), value (16) and weight $\{\alpha(i_1)\}_{i_1=1}^{5}$ (Figure 3).

For operational management, the averaged matrix according to $\{\mathbf{F}_h\}_{h=1}^{30}$, probability (4), value (6) and weight $\{\alpha(i_2)\}_{i_2=1}^{5}$ (Figure 4).

0	0.3333	-1.0000	-0.9333	-1.0000
-0.4000	0	-1.0000	-1.0000	-1.0000
1.0000	1.0000	0	0.8667	0.4000
1.0000	1.0000	-0.8667	0	-0.8000
1.0000	1.0000	-0.3333	0.8000	0
0	0.3333	0	0	0
0	0	0	0	0
1.0000	1.0000	0	0.8667	0.4000
1.0000	1.0000	0	0	0
1.0000	1.0000	0	0.8000	0
0.3046	0.1000	21.4322	20.0000	20.9062
0.0049	0.0016	0.3416	0.3188	0.3332

Figure 3. The average matrixfor strategic management according to $\{\mathbf{F}_h\}_{h=1}^{30}$, probability (4), value(16) and weight $\{\alpha(i_1)\}_{i_1=1}^{5}$on the basis of"Karlivsky machine-building enterprise" data

0	1.0000	0.4667	0.7333	1.0000
-1.0000	0	-1.0000	-1.0000	-0.9333
-0.2667	1.0000	0	0.6667	1.0000
-0.9333	1.0000	-0.6000	0	0.5333
-1.0000	0.9333	-1.0000	-0.5333	0
0	1.0000	0.4667	0.7333	1.0000
0	0	0	0	0
0	1.0000	0	0.6667	1.0000
0	1.0000	0	0	0.5333
0	0.9333	0	0	0
21.2259	0.1000	20.6841	10.5147	1.2968
0.3944	0.0019	0.3843	0.1954	0.0241

Figure 4. The average matrixfor operational management according to $\{\mathbf{F}_h\}_{h=1}^{30}$, probability (4), value (6) and weight $\{\alpha(i_2)\}_{i_2=1}^{5}$on the basis of"Karlivsky machine-building enterprise" data

For financial management, the averaged matrix according to $\{\mathbf{F}_h\}_{h=1}^{30}$, probability (4), value (6) and weight $\{\alpha(i_3)\}_{i_3=1}^{5}$(Figure 5).

For innovation management, the averaged matrix according to $\{\mathbf{F}_h\}_{h=1}^{30}$, probability (4), value (6) and weight $\{\alpha(i_4)\}_{i_4=1}^{5}$ (Figure 6).

For investment management, the averaged matrix according to $\{\mathbf{F}_h\}_{h=1}^{30}$, probability (4) and value (6) are, respectively, the following (Figure 7). That is why weigh $\alpha(1)=0.8373$ and $\alpha(2)=0.1627$.

For personnel management, the averaged matrix according to $\{\mathbf{F}_h\}_{h=1}^{30}$, probability (4), value (6) and weight $\{\alpha(i_6)\}_{i_6=1}^{5}$(Figure 8).

Finally, for marketing management, the averaged matrix according to $\{\mathbf{F}_h\}_{h=1}^{30}$, probability (4), value (6) and weight $\{\alpha(i_7)\}_{i_7=1}^{4}$ (Figure 9).

0	1.0000	1.0000	0.6000	1.0000
-1.0000	0	-0.6000	-1.0000	0.4667
-0.9333	0.6667	0	-0.9333	1.0000
-0.5333	1.0000	0.6000	0	1.0000
-1.0000	-0.5333	-1.0000	-1.0000	0

0	1.0000	1.0000	0.6000	1.0000
0	0	0	0	0.4667
0	0.6667	0	0	1.0000
0	1.0000	0.6000	0	1.0000
0	0	0	0	0

30.5951	0.4405	10.6841	20.5951	0.1000

0.4902	0.0071	0.1712	0.3300	0.0016

Figure 5. The average matrixfor financial managementaccording to $\{\mathbf{F}_h\}_{h=1}^{30}$, probability (4), value(6) and weight $\{\alpha(i_3)\}_{i_3=1}^{5}$ on the basis of"Karlivsky machine-building enterprise" data

0	-1.0000	-0.9333	-1.0000	-1.0000
1.0000	0	1.0000	0.5333	-0.8667
0.8000	-1.0000	0	-0.6667	-1.0000
1.0000	-0.6667	0.7333	0	-1.0000
1.0000	0.9333	1.0000	1.0000	0

0	0	0	0	0
1.0000	0	1.0000	0.5333	0
0.8000	0	0	0	0
1.0000	0	0.7333	0	0
1.0000	0.9333	1.0000	1.0000	0

0.1000	20.5147	0.9062	10.7854	31.2968

0.0016	0.3225	0.0142	0.1696	0.4921

Figure 6. The average matrixfor innovation managementaccording to $\{\mathbf{F}_h\}_{h=1}^{30}$, probability (4), value (6) and weight $\{\alpha(i_3)\}_{i_3=1}^{5}$ on the basis of"Karlivsky machine-building enterprise" data

0	0.5333
-0.5333	0

0	0.5333
0	0

0.5147	0.1000

Figure 7. The average matrixfor investment management по $\{\mathbf{F}_h\}_{h=1}^{30}$, probability (4), value (6) and weight $\{\alpha(i_3)\}_{i_3=1}^{5}$ on the basis of"Karlivsky machine-building enterprise" data

0	-0.6000	0.6000	0.8667	-1.0000
0.5333	0	1.0000	1.0000	-0.8667
-0.5333	-1.0000	0	0.2000	-1.0000
-0.9333	-1.0000	-0.4667	0	-1.0000
1.0000	0.9333	1.0000	1.0000	0

0	0	0.6000	0.8667	0
0.5333	0	1.0000	1.0000	0
0	0	0	0.2000	0
0	0	0	0	0
1.0000	0.9333	1.0000	1.0000	0

1.6565	20.5147	0.1791	0.1000	31.2968

0.0308	0.3817	0.0033	0.0019	0.5823

Figure 8. The average matrixfor personnel managementaccording to $\{\mathbf{F}_h\}_{h=1}^{30}$, probability (4), value (6) and weight $\{\alpha(i_3)\}_{i_3=1}^{5}$ on the basis of"Karlivsky machine-building enterprise" data

0	-1.0000	-0.9333	0.0667
1.0000	0	0.3333	1.0000
0.7333	-0.2667	0	0.7333
-0.2000	-1.0000	-0.9333	0

0	0	0	0.0667
1.0000	0	0.3333	1.0000
0.7333	0	0	0.7333
0	0	0	0

0.0592	20.3046	1.5709	0.1000

0.0027	0.9215	0.0713	0.0045

Figure 9. The average matrixfor marketing managementaccording to $\{\mathbf{F}_h\}_{h=1}^{30}$, probability (4), value (6) and weight $\{\alpha(i_3)\}_{i_3=1}^{5}$ on the basis of"Karlivsky machine-building enterprise" data

The rest of the point estimates for each type of management are calculated similarly. Subsequently, local estimates (11) were calculated in the Matlab environment, which results are as follows (Figure 10).

Finally, according to the ratio (13), the overall assessment of the state of the economic security system of LLC "Karlivsky machine-building enterprise" is as follows:

$$S_{SESE} = \sum_{k=1}^{7} \mu_k \cdot s_k = 0.0008 \cdot 0.5205 + 0.0925 \cdot$$
$$\cdot 0.7468 + 0.0083 \cdot 0.0709 + 0.3193 \cdot 0.3380 +$$
$$+ 0.3245 \cdot 0.0163 + 0.0839 \cdot 0.5289 + 0.1709 \cdot$$
$$\cdot 0.1484 = 0.253.$$

The low assessment of the state of the economic security system of LLC "Karlivsky machine-building enterprise" also indicates the imbalance of the system, since $\frac{s_2}{s_5} = \frac{0.7468}{0.0163} = 45.898$.

```
>> load a1
>> a1
a1 =
    0.0049    0.0016    0.3416    0.3188    0.3332
>> s1 = sum(a1.*[0 0.35 0.08 0.5 1])
s1 =
    0.5205
>> load a2
>> a2
a2 =
    0.3944    0.0019    0.3843    0.1954    0.0241
>> s2 = sum(a2.*[0.5 0.9 1 0.8 0.3])
s2 =
    0.7468
>> load a3
>> a3
a3 =
    0.4902    0.0071    0.1712    0.3300    0.0016
>> s3 = sum(a3.*([0 2.35 0.6 0.14 0.65]/2.35))
s3 =
    0.0709
>> load a4
>> a4
a4 =
    0.0016    0.3225    0.0142    0.1696    0.4921
>> s4 = sum(a4.*([0.35 14.5 0.094 0.09 0.42]/14.5))
s4 =
    0.3380
>> load a5
>> a5
a5 =
    0.8373    0.1627
>> s5 = a5(1)*0 + a5(2)*0.1
s5 =
    0.0163
>> load a6
>> a6
a6 =
    0.0308    0.3817    0.0033    0.0019    0.5823
>> s6 = sum(a6.*[0.15 0.8 1 1 0.367])
s6 =
    0.5289
>> load a7
>> a7
a7 =
    0.0027    0.9215    0.0713    0.0045
>> s7 = sum(a7.*[0.9 0.15 0.1 0.13])
s7 =
    0.1484
```

Figure 10. The local estimates (11) for"Karlivsky machine-building enterprise"

The imbalance of the enterprise economic security system is manifested in the significant difference in local assessments that describe the state of each management type. If local estimates are not very different from each other, regardless of whether they are high or not, the system should be considered as balanced.

The imbalance of the economic security system of LLC "Karlivsky machine-building enterprise" is manifested in the negative state of financial and investment types of management, local estimates of which are the smallest (less than 0.1) according to (11).

The estimation of the state of the economic security system of PC "Machine-building enterprise "Komsomolets" was determined in a similar sequence (13):

$$S_{SESE} = \sum_{k=1}^{7} \mu_k \cdot s_k = 0.0017 \cdot 0.5032 + 0.0195 \cdot 0.6833 + 0.0015 \cdot 0.0993 + 0.4186 \cdot 0.2819 + 0.3907 \cdot 0.2203 + 0.0283 \cdot 0.1124 + 0.1395 \cdot 0.1453 = 0.2419.$$

The estimation of the state of the economic security system of PC "Machine-building enterprise "Komsomolets" (13) is worse than the estimation of the state of the system of LLC "Karlivsky machine-building enterprise", although the imbalance of the system is not so low:

$$\frac{s_2}{s_3} = \frac{0.6833}{0.0993} = 6.8812$$

The "bottleneck" of the PC "Machine-building enterprise "Komsomolets" is financial management, which local assessment (11) is the smallest (close, but still less than 0.1).

For LLC "Elba" weight distribution $\{\mu_k\}_{k=1}^{7}$ is close to the weight distribution for PC "Machine-building enterprise "Komsomolets". But the overall assessment of the state of the economic security system of LLC "Elba" is almost twice as high as the estimates made for the PC "Machine-building enterprise "Komsomolets", LLC "Karlivsky machine-building enterprise":

$$S_{SESE} = \sum_{k=1}^{7} \mu_k \cdot s_k = 0.0014 \cdot 0.6543 + 0.0106 \cdot$$
$$\cdot 0.8439 + 0.0009 \cdot 0.2543 + 0.4420 \cdot 0.4333 +$$
$$+ 0.4030 \cdot 0.5634 + 0.0293 \cdot 0.3232 + 0.1128 \cdot$$
$$\cdot 0.0033 = 0.4385.$$

However, the economic security system of LLC "Elba" is considered to be unbalanced, for example, marketing management has a very low rating –

$$\frac{s_2}{s_7} = \frac{0.8439}{0.0033} = 255.7273$$

It can be assumed that this is due to the fact that the company, being the exclusive representative of ALC "Tvorovsky", has a well-established consumer base: trade networks of Ukraine Fozzy Group, Retail Group, CJSC "Furshet", Velyka Kyshenia, Amstor, Metro, X-5, EKO-market, ATB-market) and gas stations (OKKO, CLO, TNK, Shell, WOG).

The imbalance of the economic security system of LLC "Elba" virtually eliminates the positive contribution of strategic and operational management with their relatively high estimates.

The obtained assessments of the state of the economic security system and its balance (imbalance) are given in Table 3.

Table 3. Assessment of the state of the economic security system of the analyzed enterprises

Enterprise	Assessment of the state of the economic security system
LLC "Karlivsky machine-building enterprise"	0,253
PC "Machine-building enterprise "Komsomolets"	0,2419
LLC "Elba"	0,4385

5. Conclusions

According to the results of the assessment of the state of the economic security system of the analyzed enterprises, the following conclusions were made. Low estimates indicate the unsatisfactory state of their economic security system, which is explained, rather, not by the state of the system as it is, but by the fact that the formation of the system in these enterprises at their beginning. But at the same time, though indirectly, the obtained assessment of the state of the economic security system of the analyzed enterprises indicates the threatening state of their economic security. It became possible either in the absence of the necessary attention to the provision of economic security, or in the presence of a truly threatening and aggressive environment of the enterprise, to which companies have nothing to oppose. That is, the company can not protect its activities yet, due to a variety of different reasons: there is no relevant experience, knowledge and specialists, there is no definitive awareness of the importance of providing economic security, there are no resources for security measures (especially preventive), etc. The imbalance of the system of the economic system of the analyzed enterprises also has reasons: this is a high competition in the market of products prodused by the analyzed enterprises, a general decrease in the profitability of domestic enterprises (the analyzed enterprises are not the exception, and the situation is getting degraded by the seasonal nature of the activity of product consumers).

The model proposed in the study does not "narrow" the assessment to determine only the resulting indicator of the state of the economic security system based on several criteria, but also allows using the expert assessment and appropriate mathematical tools (matrix ranking, Kemeny median) to evaluate the CEBP balance, identify its imperfection and determine " bottlenecks "within a specific type of management, which further specify the model users' actions.

In contrast to the existing models of the CEBP assessment (Rudnichenko et al., 2019; Varela-Vaca, Gasca, 2015; Yu et al., 2014) the model allows to single out the most important influence types of management and further operate with factors that determine their development level. The model used a matrix ranking as the most impartial type of expertise due to the streamlining procedure, which allows involving a small number of experts. This is important for the speed of processing expert assessments.

This approach contains elements of scientific novelty and makes it possible to deepen the CEBP assessing methodology as a whole.

The conducted approbation confirmed the validity of the model, its practical applicability and consistency. Test results confirm the reliability of the model and unambiguous interpretation of its results, which allows it to use it actively in practice.

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