IMPLEMENTATION OF STRATEGIC IMPERATIVES FOR STRENGTHENING THE ECONOMIC SECURITY OF TEXTILE ENTERPRISES THROUGH INTRODUCTION OF AGILE MANAGEMENT SYSTEM

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Abstract: *The article proposes a model of a probabilistic neural network in order to ensure a sufficient level of economic security through the introduction of agile enterprise management system. It is built on the basis of statistical classifiers highlighting the degree of threats to economic security of enterprise. An input matrix for a probabilistic neural network was developed and a target matrix of classes (states) was formed. A probabilistic neural network was built in the environment using the built-in Matlab-function «newpnn», based on the proposed matrices. A list of management decisions that is a response to determined degree of threat was identified for each degree of threat to economic security. Detailing of management decisions in terms of individual components allows managers to understand the response to the current threat from the standpoint of effective management. Also, availability of alternatives expands opportunities for managers to improve existing management system in various directions. Implementation of management decisions using a neural network can reduce the degree of threats to economic security of enterprise. The article forms a target matrix of lists of actions of company's management and a crucial probabilistic neural network is built in Matlab environment. The implementation of the proposed approach is tested on the example of a particular enterprise, which indicates its suitability for practical use and solution of applied practical problems. Accordingly, the proposals developed in the study on the use of neural network allow a management of enterprise to respond quickly to current threats and risks.*

Keywords: *economic security, threats, agile management, management decisions, modeling, neural network.*

1 INTRODUCTION

The dynamism of modern environment and the crisis of the world economy caused by the COVID-19 pandemic require companies to respond effectively and quickly to change. There are constant transformations of target markets, which in most cases worsen the situation for producers and industrial sector as a whole. Information on state of markets and changes that significantly affect demand is extremely useful and relevant for making strategic decisions and adjusting the overall strategy of enterprise development [1, 2]. This necessitates the introduction of flexible management tools to ensure sufficient level of its economic security. Agile management of the enterprise allows to quickly respond and withstand challenges and threats. And this «flexibility» should be applied when managing not only the enterprise, but also the economic security system [3, 4].

The results of assessing flexibility of management system of the studied industrial enterprises indicate the need for significant improvements in management processes, and in some cases, their new architecture. Standardized, mostly directive management methods, although they ensure the prompt execution of tasks, in many cases do not contain a sufficient level of flexibility. A special place in the formation of system of agile management is occupied by management decisions that directly implement reactions of enterprise management and ensure the functioning of such a system based on information about the internal and external environment of business entities.

2 REVIEW OF LITERATURE

There are a number of methodologies that have explored various aspects of agile management, including lean manufacturing methodologies [5-7], methodologies for building and operating agile organizations [8-10] and methodologies of agile software development in construction and operation of agile organizations [11, 12]. The introduction of agile management in enterprises practice in order to ensure a sufficient level of its economic security requires taking into account threats of its activities and making informed management decisions.

Accordingly, a significant number of scientists [13, 14] focus on threats, because they are more specific and targeted and to level them it is necessary to activate the enterprise economic security, or in its absence (or rather lack of formalized representation), such actions will be generated by the existing management system.

Among the publications of Ukrainian authors covering the topic of economic security, we can single out the researches by Havlovska [13], Illiashenko [15] Kozachenko [16], Rudnichenko [17], Vasyltsiv [18] et al. Foreign approaches to the functioning of the economic security system were studied in [19-21].

To meet management needs, taking into account the degree of threats and improve decision-making system, it is advisable to use intelligent data processing systems based on construction and use of neural networks. The use of neural networks is reflected in many scientific studies, and is associated with various scientific fields, including chemistry [22, 23], physics and biology [24], industry [25], medicine [26], pharmacy [27], etc. Approaches to the use of neural networks are found in scientific publications of economic profile, in particular in studies of innovation processes [28, 29], finance [30, 31], management decisions [32, 33], pricing [34, 35], etc.

3 METHODS

We will build a system of agile enterprise management to ensure a sufficient level of its economic security on a basis of statistical classifiers. First of all, we need to identify a list of factors influencing degree of threat. Let us denote by set of all such factors:

$$Z = \left\{ z_i \right\}_{i=1}^{N} \tag{1}$$

where: Z_i is i-th factor or i-th indicator (in the terminology of statistical classifiers), which negatively affects the degree of threat (i.e., increases this degree), and N is a general number of such indicators.

For further consideration, the set (1) is represented as a combination of subsets of external and internal factors:

$$Z = \left\{ z_i \right\}_{i=1}^{N} = Z_{\text{зов}} \bigcup Z_{\text{вн}} = = \left\{ z_{i_1}^{(\text{зов})} \right\}_{i_1=1}^{N_{\text{зов}}} \bigcup \left\{ z_{i_2}^{(\text{вн})} \right\}_{i_2=1}^{N_{\text{вн}}} \tag{2}$$

where: $Z_{\text{зов}}$ and $Z_{\text{вн}}$ are subsets $N_{\text{зов}}$ of external and $N_{\text{вн}}$ internal factors, and $N = N_{\text{зов}} + N_{\text{вн}}$.

Let us denote by a set of M degrees of threat to economic security of enterprise:

$$S = \left\{ s_k \right\}_{k=1}^{M} \tag{3}$$

where: s_k is k-th degree (kind or type) of threat.

Thus, formally speaking, we face the task of not just reflecting a set of factors of influence Z into a set of degrees of threat S, but the task of classifying the degree of threat based on the study of N indicators in set Z. In other words, we need to make a choice (make a decision) according to which s^* is the most relevant threat level among all M levels:

$$s^* \in S = \left\{ s_k \right\}_{k=1}^{M} \tag{4}$$

This can be done using a statistical classifier such as a probabilistic neural network.

A probabilistic neural network is very easy to build in a Matlab environment. To do this, it is necessary to form an input matrix [36]:

$$\mathbf{F} = \left[f_{ij} \right]_{N \times (mM)} \tag{5}$$

where: $m \in \{1,2,3,\ldots\}$, and the value of the element f_{ij} is a numerical estimate (fractional or integer,

as well as from an arbitrary, generally speaking, interval) of the sign z_i in the state (class) s_k for:

$$k = j - M \cdot \psi\left(\frac{j-1}{M} \right) \tag{6}$$

where auxiliary function $\psi(x)$ returns an integer part of a number x.

Theoretically, the matrix (5) can be of $N \times M$ *size*, where m=1 and k=j according to the formula (6). In this case, each indicator in each state (degree of threat) will have only one assessment. This case is possible in calculations, but its implementation requires very reliable estimates (you need to provide $K \cdot M$ of such estimates).

Once an input matrix (7) for the probabilistic neural network is built, you only need to form the target matrix of classes (states):

$$\mathbf{T} = \left[t_{ij} \right]_{M \times (mM)} \tag{7}$$

which is a sequential horizontal concatenation of m unit matrices of size $M \times M$, where $m \in \{1,2,3,\ldots\}$.

After the matrices (5) and (7) are prepared, the probabilistic neural network $\boldsymbol{n}_{pnn}(N,M)$ in the Matlab environment is built using the built-in Matlab function «newpnn», which accepts at the input of the matrix F and T together with the parameter of the scatter of radial basis functions («spread of radial basis functions») ρ:

$$\mathbf{n}_{pnn}(N, M) = \text{newpnn}(\mathbf{F}, \mathbf{T}, \rho) \tag{8}$$

By default, the parameter ρ = 0.1 (however, this value should not be considered the recommended value of the scatter parameter). If this parameter is close to 0, the probabilistic neural network acts as a classifier of the «nearest neighbor» type. If the parameter ρ is increased, the probabilistic neural network takes into account several close (in the sense of the corresponding Euclidean metric) vectors in the matrix (5).

It is very easy to use a ready-made probabilistic neural network (8). If ***V*** is a vector with *N* features, i.e.:

$$\mathbf{V} = \left[v_i \right]_{N \times 1} \in \mathbb{R}^N \qquad (9)$$

Then in the Matlab environment with the help of the built-in Matlab-function «sim» we get:

$$\mathbf{A} = \mathrm{sim}\left(\mathbf{n}_{pnn}\left(N, M \right), \mathbf{V} \right) \qquad (10)$$

where: **A** is an *M*-dimensional vector, where *M*–1 has a value of 0 and only one element has a value of 1.

The index of an element with a value of 1 corresponds to the state number that has the most relevant degree of threat among all *M* degrees.

A set of features in the second stage will consist of $N_{ВН}$+1 element: $N_{ВН}$ of internal factors and a predicted condition or degree of threat s_{k^*}.

Let us denote this set as:

$$Z_{\text{ВН}}^{(+1)} = \left\{ s_{k^*}, \left\{ z_{i_2}^{(\text{ВН})} \right\}_{i_2=1}^{N_{\text{ВН}}} \right\} = \left\{ \vartheta_{i_2} \right\}_{i_2=1}^{N_{\text{ВН}}+1} \qquad (11)$$

Let us denote by set of $J(s_{k^*})$ possible options for action (management decisions) of the company's management to eliminate the threat of economic security in a certain state s_{k^*}.

$$D\left(s_{k^*} \right) = \left\{ d_u \left(s_{k^*} \right) \right\}_{u=1}^{J(s_{k^*})} \qquad (12)$$

Of course, this set depends on a degree of threat. Each element in it is a certain list of management decisions of an enterprise. Moreover, a list of actions of a company's management for, for example, a weak degree of threat will be smaller than for a strong or critical one.

Thus, there will be a total of *M* variants of the set (12). Each level of threat to economic security must have its own list of actions, which can be called a response to this level of threat. These lists in general will be used in our model.

Based on the sets (11) and (12), we again construct a probabilistic neural network. First, we form an input matrix of $(N_{BH}+1)$ x $(m_2 J(s_{k^*})$ size similar to the construction of the matrix (5):

$$\mathbf{F}_2 = \left[g_{i_2 j} \right]_{\left(N_{\text{ВН}}+1\right) \times \left(m_2 J\left(s_{k^*}\right) \right)} \qquad (13)$$

where: $m_2 \in \{1,2,3,\ldots\}$, and the value of the element g_{i2j} is a numerical estimate (fractional or integer, as well as from an arbitrary, generally speaking, interval) feature ϑ_{i2} in *u*-th action $d_u(s_{k^*})$ for:

$$u = j - J\left(s_{k^*} \right) \cdot \psi \left(\frac{j-1}{J\left(s_{k^*} \right)} \right) \qquad (14)$$

similar to the transformation (6). Theoretically, the matrix (13) can have a $(N_{BH}+1)$ x $(J(s_{k^*})$ size, where $m_2=1$ and $u=j$ by formula (14).

Once the input matrix (13) for a crucial probabilistic neural network is built, it is necessary to re-form the target matrix of company's management actions lists:

$$\mathbf{T}_2 = \left[t_{i_2 j} \right]_{J(s_{k^*}) \times (m_2 J(s_{k^*}))} \; (m_2 \in \{1,2,3,\ldots\}) \qquad (15)$$

which is a sequential horizontal concatenation m_2 of unit matrices of $J(s_{k^*})$ x $J(s_{k^*})$ size.

Similar to the solution of problem (4) by the first neural network, the second (decisive) probabilistic neural network solves the problem that is, we need to find the most relevant list of management decisions that will be the most effective response to the degree of threat s_k^*.

$$d^* \in D\left(s_{k^*} \right) = \left\{ d_u \left(s_{k^*} \right) \right\}_{u=1}^{J(s_{k^*})} \qquad (16)$$

After the matrices (13) and (15) are prepared, a decisive probabilistic neural network is built in the Matlab environment:

$$\mathbf{n}_{pnn}\left(N_{\text{ВН}}+1, J(s_{k^*}) \right) = \mathrm{newpnn}\left(\mathbf{F}_2, \mathbf{T}_2, \rho \right) \qquad (17)$$

where we use the same parameter of scatter of radial basis functions ρ as in the network (8). It is very easy to use a ready-made probabilistic neural network (8). If $\mathbf{V}_2$ is a vector with $N_{ВН}$+1 indicator, i.e.:

$$\mathbf{V}_2 = \left[v_{i_2}^{(2)} \right]_{(N_{\text{ВН}}+1) \times 1} \in \mathbb{R}^{N_{\text{ВН}}+1} \qquad (18)$$

then in the Matlab environment using the built-in Matlab-function «sim» we get:

$$\mathbf{A}_2 = \mathrm{sim}\left(\mathbf{n}_{pnn}\left(N_{\text{ВН}}+1, J(s_{k^*}) \right), \mathbf{V}_2 \right) \qquad (19)$$

where $\mathbf{A}_2$ is a $J(s_k^*)$-measurable vector, where $J(s_k^*)$–1 element has a value of 0 and only one element has a value of 1.

The index of an element with a value of 1 corresponds to the number of the list of management decisions that is most effective in counteracting economic threats with s_k^* degree. Thus, the response vector of the probabilistic neural network (17):

$$\mathbf{A}_2 = \left[a_u \right]_{J(s_{k^*}) \times 1} \text{ with } a_u \in \left\{ 0, 1 \right\} \qquad (20)$$

where:

$$a_u = 0 \text{ where } u \in \left\{ \overline{1, J(s_{k^*})} \right\} \setminus \left\{ u^* \right\} \text{ and } a_{u^*} = 1 \qquad (21)$$

and $d^* = d_{u^*}(s_{k^*})$ is the required list of management decisions, which is the solution to problem (16).

The expert questionnaire for estimating the input matrix of the first probabilistic neural network has the general form shown in Table 1.

The estimate of the matrix $\mathbf{F}_2$ will be similar to **F**, but we recall that there will be *M* matrices in total (each level of threat will have its own matrix). Therefore, experts should provide their opinions in *M* more questionnaires (Table 2).

Table 1 Expert questionnaire for estimates (from 0 to 1) of the matrix **F**

		Threat level				
		s_1	s_2	**...**	s_{M-1}	s_M
External factors	Z_1 – list number, an integer from 1 to $\sum_{k=1}^{M} J\,(s_k)$			**...**		
	z_2			**...**		
	⋮	⋮	⋮	⋮	⋮	⋮
	$z_{N_{3OB}-1}$			**...**		
	$z_{N_{3OB}}$			**...**		
Internal factors	$z_{N_{3OB}+1}$			**...**		
	$z_{N_{3OB}+2}$			**...**		
	⋮	⋮	⋮	⋮	⋮	⋮
	z_{N-1}			**...**		
	z_N			**...**		

Table 2 Expert questionnaire for assessments (from 0 to 1) of the **F**$_2$ matrix for the s_k $(k = \overline{1,M})$ level threat

		Lists of management decisions to eliminate the s_k level threat				
		1	**2**	**...**	**$J(s_k)$-1**	**$J(s_k)$**
Level threat (defined at the previous stage)	$s_k(\vartheta_1)$					
Internal factors	$z_{N_{3OB}}+1(\vartheta_2)$			**...**		
	$z_{N_{3OB}}+2(\vartheta_3)$			**...**		
	⋮	⋮	⋮	⋮	⋮	⋮
	$z_{N-1}(\vartheta_{N_{BH}})$			**...**		
	$z_N(\vartheta_{N_{BH}+1})$			**...**		

Table 3 Expert questionnaire for estimates (from 0 to 1 in vector V) of the threat increase intensity

Signs (influencing factors)	**z_1 (list number, integer)**	**z_2**	**...**	**$z_{N_{3OB}}$+1**	**$z_{N_{3OB}}$**	**$z_{N_{3OB}}$**	**$z_{N_{3OB}}$+2**	**...**	**z_{N-1}**	**z_N**
Estimate (judgment)	* this rating is provided only before the system starts		**...**					**...**		

Table 4 Expert questionnaire for assessments (from 0 to 1 in the vector V2) of the feasibility of making a list of management decisions $d_u(s_{k^*})$ to eliminate s_{k^*} **level threat** (defined in the previous stage)

Signs	$z_{N_{3OB}+1}(\vartheta_2)$	$z_{N_{3OB}+2}(\vartheta_3)$	**...**	$Z_{N-1}(\vartheta_{N_{BH}})$	$Z_N(\vartheta_{N_{BH}+1})$
Estimate (judgment)			**...**		

After receiving all the matrices for the two neural networks, we run a flexible control system. In this system it will be necessary to evaluate vectors (9) and (18) monthly or quarterly (for a relatively short period of time) to supply them to the inputs of the first and second neural networks, respectively. Estimates of vectors **V** and **V**$_2$ will also be obtained with the help of expert judgments (Table 3 and Table 4).

4 RESULTS

Let us consider specific examples of the implementation of the developed system on the example of PJSC «Lileia», which is a very powerful enterprise of light industry.

The management of this enterprise has established that objectively there are five levels of threats (from the lowest to the highest). The lowest degree of threat is such that has almost no effect on economic performance and development (stable support) of production. Signs of threats are given in Table 5.

In this case, the degree of threat has different lists of management decisions to eliminate (weaken) 2, 2, 3, 4, 6 respectively. The content of these lists is given in Table 6.

Table 5 Signs of threats to economic security of PJSC «Lileia»

<table>
<tr><th>Threat level</th><th>Weak</th><th>Slight</th><th>Moderate</th><th>Strong</th><th>Critical</th></tr>
<tr><td>List of management decisions that theoretically do not help eliminate this threat</td><td colspan="5">Integer from 1 to 17 (see Table 2)</td></tr>
<tr><td>External factors</td><td colspan="5">1) deepening economic crisis;
2) increasing competition;
3) acquisition by another company;
4) raiding;
5) unfavorable changes in relevant legislation;
6) exchange rate fluctuations;
7) changing fashion trends;
8) natural disasters;
9) pandemic and appropriate quarantine measures;
10) military action</td></tr>
<tr><td>Internal factors</td><td colspan="5">1) lack of resources;
2) low quality of resources;
3) obsolescence of equipment and technologies;
4) opportunistic behavior of employees;
5) conflicts between owners and management of enterprise;
6) loss of skilled workers;
7) absence or imperfection, poor (unsatisfactory, unstable) functioning of marketing system.</td></tr>
</table>

Table 6 Degrees of threats to the economic security of PJSC «Lileia» and the corresponding lists of management decisions for their mitigation

<table>
<tr><th>Threat level</th><th colspan="12">Lists of management decisions for threats mitigation</th></tr>
<tr><td>Weak</td><td colspan="6">1) introduction of minor incentives for employees, advertisement on social networks</td><td colspan="6">2) partial reduction of working hours, partial (minimum) rebranding, promotion of the best products with the help of loyal partner companies</td></tr>
<tr><td>Slight</td><td colspan="6">3) introduction of permanent incentives to employees on the basis of production indicators and sales, regular advertising on social networks</td><td colspan="6">4) partial reduction of working hours, partial (minimum) rebranding, regular advertising on social networks and «promotion» of YouTube channels</td></tr>
<tr><td>Moderate</td><td colspan="4">5) introduction of permanent incentives for employees on the basis of production indicators and sales, regular advertising on social networks, introduction of a trial (temporary) system of penalties for lateness, search for new (alternative) resource suppliers</td><td colspan="4">6) partial (minimal) rebranding, regular advertising on social networks and «promotion» of YouTube channels, search for new (alternative) resource providers abroad</td><td colspan="4">7) partial upgrade of equipment, introduction of a trial (temporary) system of penalties for lateness, creation of a new marketing department, promotion of the best products with the help of loyal partner companies</td></tr>
<tr><td>Strong</td><td colspan="3">8) regular advertising on social networks and «promotion» of YouTube channels, search for new (alternative) resource suppliers abroad, partial upgrade of equipment, search for grants</td><td colspan="3">9) reduction of expenses due to depreciation funds, search for grants, regular advertising on social networks and «promotion» of YouTube channels</td><td colspan="3">10) partial renewal of equipment at the expense of depreciation funds, introduction of permanent incentives to employees on the basis of production indicators and sales, moderate rebranding</td><td colspan="3">11) reduction of production, reduction of number of employees, production of new products at the expense of partial production wastes, reduction of expenses at the expense of depreciation funds</td></tr>
<tr><td>Critical</td><td colspan="2">12) introduction of a permanent system of penalties for lateness, reduction of the number of employees, increase in prices for the most popular products</td><td colspan="2">13) reduction of expenses at the expense of depreciation funds, introduction of permanent incentives to employees on the basis of production indicators and sales, reduction of prices</td><td colspan="2">14) partial sale of obsolete equipment, increase in prices for the most popular products, advertising on social networks and «promotion» of YouTube channels</td><td colspan="2">15) moderate rebranding, introduction of permanent incentives to employees on the basis of production indicators and sales, introduction of a permanent system of penalties for lateness without staff reductions</td><td colspan="2">16) moderate rebranding, significant reduction in staff, advertising on social networks and «promotion» of YouTube channels, introduction of permanent incentives to employees based on performance and sales</td><td colspan="2">17) full rebranding, reduction of employees, advertising on social networks and «promotion» of YouTube channels</td></tr>
</table>

A total of 29 experts were involved in PJSC «Lileia» study. This expert group mainly includes representatives of the management and leadership of this enterprise. As a result, the input matrix for the first probabilistic neural network (Table 7) was obtained after optimal clustering of expert judgments, it consisted of two submatrices (i.e., here *m*=2).

When evaluating the five $\mathbf{F}_2$ matrices, the expert judgments were clustered into three clusters and, therefore, m_2=2. These matrices for each state are given in Tables 8–12.

Table 7 Input Matrix F for PJSC «Lileia»

Threat level		Weak	Slight	Moderate	Strong	Critical	Weak	Slight	Moderate	Strong	Critical
normal list		0.130	0.071	0.424	0.478	0.915	0.133	0.290	0.218	0.723	0.758
External factors	1	0.130	0.169	0.305	0.617	0.712	0.080	0.179	0.265	0.586	0.688
	2	0.300	0.394	0.307	0.575	0.397	0.236	0.385	0.251	0.603	0.412
	3	0.098	0.410	0.485	0.699	0.955	0.074	0.381	0.476	0.756	0.840
	4	0.067	0.608	0.653	0.776	0.793	0.050	0.577	0.698	0.807	0.813
	5	0.325	0.428	0.484	0.585	0.680	0.318	0.375	0.519	0.617	0.710
	6	0.076	0.148	0.265	0.548	0.652	0.099	0.125	0.257	0.616	0.652
	7	0.169	0.378	0.524	0.402	0.386	0.221	0.420	0.504	0.383	0.403
	8	0.071	0.100	0.164	0.261	0.333	0.084	0.097	0.215	0.278	0.301
	9	0.456	0.595	0.688	0.801	0.937	0.522	0.614	0.648	0.804	0.838
	10	0.107	0.184	0.192	0.191	0.240	0.093	0.187	0.163	0.269	0.236
Internal factors	1	0.075	0.219	0.291	0.415	0.489	0.127	0.201	0.316	0.421	0.491
	2	0.321	0.564	0.619	0.723	0.836	0.255	0.546	0.680	0.726	0.909
	3	0.299	0.358	0.292	0.276	0.293	0.302	0.408	0.304	0.306	0.298
	4	0.154	0.301	0.225	0.399	0.426	0.259	0.300	0.236	0.451	0.467
	5	0.388	0.214	0.325	0.376	0.353	0.414	0.202	0.337	0.366	0.409
	6	0.321	0.439	0.451	0.490	0.765	0.326	0.389	0.458	0.506	0.746
	7	0.275	0.411	0.485	0.569	0.626	0.287	0.420	0.555	0.543	0.574

Table 8 Input Matrix $\mathbf{F}_2$ for PJSC «Lileia» for a weak degree of threat

		Lists of management decisions					
		1	***2***	***1***	***2***	***1***	***2***
	Weak degree of threat	0.092	0.085	0.096	0.13	0.146	0.147
Internal factors	1	0.137	0.239	0.172	0.173	0.123	0.200
	2	0.379	0.552	0.467	0.490	0.433	0.444
	3	0.165	0.205	0.223	0.067	0.055	0.075
	4	0.444	0.087	0.521	0.087	0.547	0.050
	5	0.638	0.080	0.589	0.125	0.641	0.043
	6	0.648	0.219	0.608	0.180	0.514	0.303
	7	0.336	0.430	0.280	0.491	0.351	0.382

Table 9 Matrix $\mathbf{F}_2$ for PJSC «Lileia» for a minor degree of threat

		Lists of management decisions					
		3	***4***	***3***	***4***	***3***	***4***
	Minor degree of threat	0.076	0.198	0.119	0.168	0.057	0.262
Internal factors	1	0.092	0.223	0.215	0.195	0.100	0.172
	2	0.424	0.452	0.456	0.378	0.466	0.485
	3	0.235	0.056	0.195	0.136	0.257	0.114
	4	0.375	0.359	0.452	0.409	0.447	0.342
	5	0.196	0.477	0.204	0.312	0.148	0.323
	6	0.123	0.286	0.296	0.301	0.183	0.360
	7	0.536	0.291	0.391	0.254	0.349	0.317

Table 10 Matrix $\mathbf{F}_2$ for PJSC «Lileia» at a moderate degree of threat

		Lists of management decisions								
		5	***6***	***7***	***5***	***6***	***7***	***5***	***6***	***7***
	Moderate degree of threat	0.453	0.548	0.458	0.478	0.463	0.335	0.46	0.445	0.389
Internal factors	1	0.078	0.086	0.423	0.105	0.058	0.291	0.056	0.067	0.255
	2	0.105	0.203	0.47	0.187	0.17	0.332	0.073	0.092	0.475
	3	0.113	0.583	0.116	0.203	0.555	0.046	0.259	0.542	0.115
	4	0.394	0.393	0.247	0.372	0.339	0.277	0.473	0.459	0.216
	5	0.528	0.28	0.707	0.62	0.375	0.688	0.604	0.327	0.689
	6	0.503	0.545	0.175	0.499	0.49	0.204	0.438	0.592	0.21
	7	0.248	0.294	0.101	0.277	0.325	0.118	0.279	0.282	0.097

Table 11 Matrix F_2 for PJSC «Lileia» for a strong degree of threat

		Lists of management decisions											
		8	***9***	***10***	***11***	***8***	***9***	***10***	***11***	***8***	***9***	***10***	***11***
	Strong degree of threat	0.806	0.419	0.131	0.080	0.694	0.368	0.137	0.097	0.810	0.387	0.108	0.094
Internal factors	1	0.664	0.104	0.11	0.174	0.749	0.077	0.169	0.169	0.722	0.140	0.089	0.245
	2	0.635	0.099	0.101	0.177	0.699	0.084	0.114	0.180	0.705	0.189	0.132	0.228
	3	0.101	0.215	0.713	0.168	0.062	0.176	0.868	0.294	0.078	0.094	0.823	0.169
	4	0.217	0.363	0.678	0.458	0.257	0.245	0.671	0.296	0.175	0.263	0.591	0.434
	5	0.319	0.163	0.759	0.078	0.220	0.227	0.809	0.046	0.211	0.269	0.616	0.067
	6	0.559	0.171	0.934	0.180	0.507	0.343	0.867	0.143	0.620	0.166	0.881	0.090
	7	0.106	0.336	0.293	0.451	0.101	0.306	0.355	0.426	0.157	0.252	0.401	0.337

Table 12 Matrix F_2 for PJSC «Lileia» for a critical level of threat

		Lists of management decisions																	
		12	***13***	***14***	***15***	***16***	***17***	***12***	***13***	***14***	***15***	***16***	***17***	***12***	***13***	***14***	***15***	***16***	***17***
Critical level of threat		0.027	0.330	0.488	0.766	0.824	0.994	0.150	0.285	0.509	0.672	0.900	0.992	0.097	0.311	0.543	0.685	0.851	0.923
Internal factors	1	0.127	0.225	0.353	0.460	0.180	0.274	0.113	0.186	0.286	0.366	0.178	0.318	0.183	0.274	0.385	0.447	0.228	0.273
	2	0.384	0.508	0.622	0.091	0.118	0.085	0.410	0.561	0.563	0.161	0.057	0.099	0.384	0.511	0.613	0.179	0.118	0.032
	3	0.36	0.467	0.311	0.668	0.130	0.129	0.398	0.398	0.341	0.680	0.085	0.174	0.309	0.447	0.331	0.718	0.105	0.313
	4	0.424	0.249	0.146	0.824	0.665	0.897	0.513	0.406	0.299	0.954	0.755	0.973	0.504	0.382	0.293	0.941	0.700	0.980
	5	0.240	0.23	0.294	0.354	0.636	0.881	0.120	0.192	0.365	0.383	0.676	0.934	0.168	0.176	0.375	0.417	0.778	0.838
	6	0.247	0.285	0.464	0.898	0.471	0.737	0.342	0.404	0.325	0.894	0.578	0.840	0.240	0.248	0.405	0.926	0.437	0.757
	7	0.446	0.334	0.458	0.246	0.88	0.939	0.335	0.357	0.463	0.235	0.969	0.890	0.221	0.370	0.361	0.394	0.935	0.861

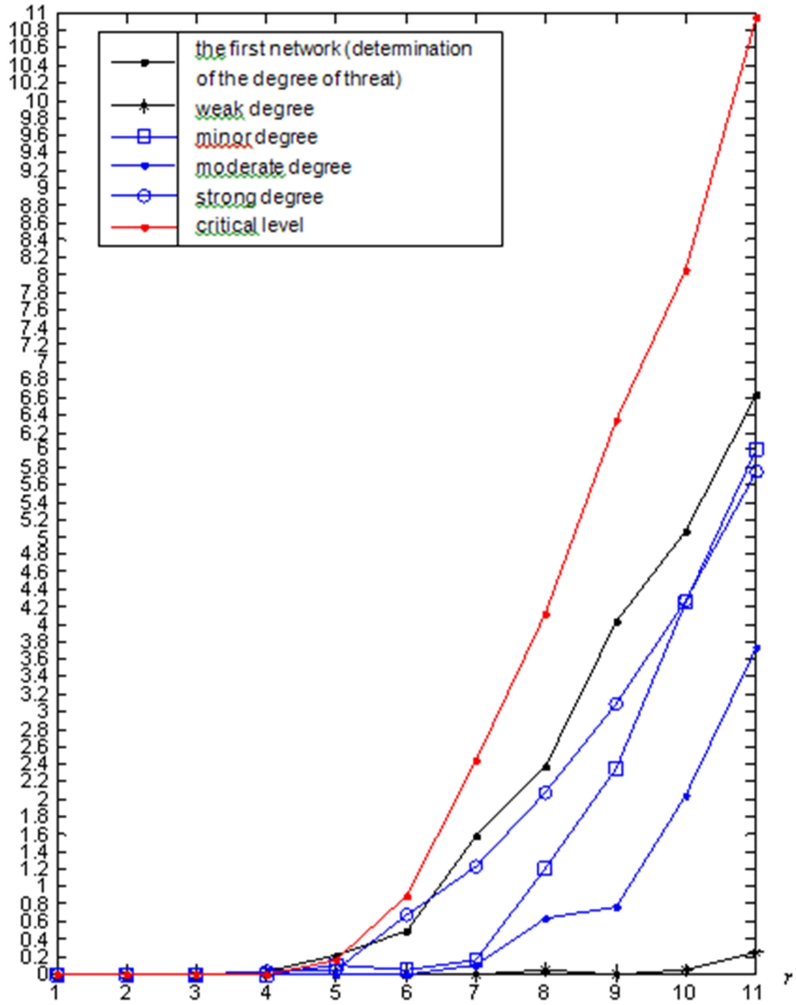

Figure 1 The performance of probabilistic neural networks in the form of the average percentage of erroneous answers for PJSC "Lileia"

After all the necessary data were collected, two probabilistic neural networks (8) and (17) were constructed. Their performance was studied according to the scheme:

$$\mathbf{F}_{\text{test}} = \overline{\mathbf{F}} + \zeta \cdot \left(\frac{r-1}{10} \right) \cdot \Theta + \xi \cdot \left(\frac{r-1}{10} \right) \cdot \Theta_1 \quad (r = \overline{1,11}) \quad (22)$$

where: $\bar{F}$ – averaged input matrix, Θ – matrix of randomly distributed values with zero mean, Θ_1 – matrix of randomly distributed values with zero mean, in which all columns are the same, ζ=0.15, ζ=0.075.

Next, the matrices (22) are fed to the input of the corresponding neural network in the manner of (10) and (19) and the statistics of responses are examined. In fact, expression (22) is a model of noise and discrepancies in expert judgments [37]. In this case, the performance of the neural network means the percentage of erroneous responses. Figure 1 shows all six dependences of this percentage (for all neural networks) on the level of noise and discrepancies $r = \overline{1,11}$.

Neural network diagnostics for agile control was performed as follows. As of April 3, 2020, the same 29 experts had evaluated the **V** and $\mathbf{V}_2$ vectors every Friday for two weeks.

Tables 13 and 14 show all such vector estimates that were applied to the input of neural networks (8) and (17), respectively.

Table 13 List of vectors V for PJSC «Lileia» and responses of the first neural network (8)

Date	Normal list	External factors (by numbers)										Internal factors (by numbers)							Network response (threat level)
		1	2	3	4	5	6	7	8	9	10	1	2	3	4	5	6	7	
03.04	0.118	0.473	0.387	0.338	0.710	0.490	0.081	0.635	0.470	0.668	0.281	0.166	0.544	0.069	0.162	0.573	0.253	0.395	**3**
17.04	0.412	0.134	0.217	0.575	0.771	0.536	0.259	0.552	0.363	0.500	0.154	0.433	0.675	0.220	0.321	0.208	0.655	0.286	**3**
01.05	0.412	0.439	0.456	0.319	0.895	0.388	0.257	0.488	0.167	0.592	0.004	0.336	0.717	0.172	0.171	0.128	0.356	0.542	**3**
15.05	0.294	0.698	0.271	0.693	0.598	0.587	0.560	0.348	0.346	0.804	0.330	0.290	0.876	0.152	0.708	0.285	0.656	0.507	**4**
29.05	0.471	0.300	0.372	0.744	0.753	0.486	0.100	0.676	0.234	0.760	0.014	0.218	0.998	0.370	0.328	0.271	0.597	0.555	**3**
12.06	0.294	0.404	0.223	0.260	0.824	0.513	0.365	0.654	0.213	0.752	0.335	0.341	0.935	0.389	0.315	0.477	0.532	0.673	**3**
26.06	0.294	0.588	0.578	0.892	0.944	0.495	0.777	0.520	0.282	0.627	0.328	0.322	0.845	0.114	0.251	0.138	0.624	0.777	**4**
10.07	0.529	0.133	0.196	0.393	0.755	0.589	0.218	0.369	0.207	0.808	0.244	0.319	0.500	0.455	0.470	0.312	0.323	0.636	**3**
24.07	0.294	0.312	0.521	0.206	0.487	0.657	0.346	0.677	0.181	0.843	0.002	0.372	0.537	0.294	0.142	0.561	0.345	0.253	**3**
07.08	0.412	0.181	0.317	0.260	0.697	0.337	0.102	0.290	0.189	0.511	0.333	0.301	0.468	0.534	0.408	0.267	0.445	0.593	**2**
21.08	0.235	0.038	0.369	0.525	0.661	0.300	0.096	0.478	0.058	0.706	0.580	0.086	0.563	0.486	0.551	0.177	0.371	0.328	**2**
04.09	0.235	0.098	0.404	0.351	0.268	0.363	0.032	0.274	0.022	0.767	0.225	0.360	0.580	0.363	0.257	0.392	0.512	0.437	**2**
18.09	0.235	0.147	0.290	0.512	0.583	0.418	0.322	0.383	0.073	0.634	0.077	0.204	0.570	0.164	0.102	0.277	0.576	0.210	**2**
02.10	0.235	0.377	0.336	0.440	0.783	0.466	0.311	0.491	0.183	0.703	0.381	0.314	0.796	0.428	0.228	0.185	0.536	0.705	**3**
16.10	0.412	0.239	0.158	0.355	0.589	0.414	0.068	0.144	0.443	0.663	0.187	0.376	0.648	0.371	0.288	0.126	0.489	0.312	**3**
30.10	0.294	0.141	0.484	0.369	0.658	0.452	0.033	0.385	0.038	0.642	0.296	0.379	0.657	0.404	0.276	0.274	0.428	0.290	**2**
13.11	0.235	0.004	0.421	0.067	0.042	0.405	0.120	0.047	0.133	0.471	0.005	0.207	0.160	0.518	0.228	0.225	0.305	0.426	**1**
27.11	0.118	0.168	0.458	0.421	0.771	0.462	0.162	0.453	0.087	0.469	0.099	0.250	0.616	0.531	0.394	0.318	0.119	0.291	**2**
11.12	0.235	0.081	0.286	0.065	0.206	0.316	0.061	0.215	0.202	0.521	0.307	0.011	0.088	0.188	0.239	0.302	0.402	0.425	**1**
25.12	0.059	0.164	0.206	0.088	0.138	0.382	0.304	0.058	0.030	0.607	0.011	0.119	0.180	0.645	0.214	0.410	0.674	0.353	**1**

Table 14 List of vectors V2 for PJSC «Lileia» and responses of the original neural network (17)

Date	Normal degree of threat	Internal factors (by numbers)							The most relevant list of management decisions (see Table 2)
		1	2	3	4	5	6	7	
03.04	0.6	0.162	0.065	0.054	0.338	0.567	0.388	0.171	**7**
17.04	0.6	0.076	0.326	0.732	0.137	0.282	0.690	0.425	**7**
01.05	0.6	0.281	0.061	0.796	0.458	0.272	0.231	0.120	**5**
15.05	0.8	0.050	0.022	0.547	0.679	0.958	0.989	0.029	**8**
29.05	0.6	0.183	0.038	0.175	0.563	0.718	0.511	0.043	**5**
12.06	0.6	0.261	0.662	0.238	0.035	0.824	0.230	0.300	**5**
26.06	0.8	0.575	0.627	0.318	0.144	0.291	0.338	0.017	**9**
10.07	0.6	0.210	0.033	0.168	0.409	0.584	0.486	0.273	**5**
24.07	0.6	0.405	0.385	0.155	0.207	0.579	0.143	0.050	**7**
07.08	0.4	0.215	0.634	0.148	0.396	0.455	0.254	0.672	**4**
21.08	0.4	0.128	0.352	0.247	0.145	0.148	0.107	0.460	**4**
04.09	0.4	0.249	0.620	0.249	0.390	0.527	0.299	0.350	**4**
18.09	0.6	0.085	0.037	0.829	0.254	0.304	0.585	0.268	**4**
02.10	0.6	0.406	0.350	0.149	0.093	0.515	0.140	0.171	**7**
16.10	0.4	0.048	0.480	0.091	0.275	0.361	0.232	0.406	**5**
30.10	0.4	0.386	0.388	0.031	0.538	0.291	0.362	0.440	**4**
13.11	0.2	0.099	0.500	0.164	0.490	0.716	0.501	0.375	**2**
27.11	0.4	0.168	0.362	0.098	0.310	0.028	0.150	0.704	**4**
11.12	0.2	0.193	0.222	0.212	0.271	0.506	0.532	0.181	**1**
25.12	0.2	0.218	0.422	0.125	0.017	0.210	0.435	0.327	**2**

5 CONCLUSION

As we can see, thanks to the developed system of flexible management at PJSC «Lileia» (which has been implemented since the beginning of April 2020) it was possible to stabilize and eliminate threats to its economic security within four months. At the beginning of August 2020, the degree of threat was insignificant (see the darker colors of the more threatening situations in Tables 9 and 10), and this situation lasted until mid-September. At the same time, the most relevant list of management decisions in this period were actions aimed at partial reduction of working hours, partial (minimum) rebranding, as well as the introduction and further support of regular advertising on social networks and «promotion» of YouTube channels (see Table 2). Threats continued to rise due to deteriorating external factors (in particular, the economic crisis in Ukraine deepened), but in early November, PJSC «Lileia» management managed to stabilize the situation through flexible responses to threats. Finally, in order to maintain control over threats, PJSC «Lileia» management further supports the introduction of small incentives for employees, along with partial reductions in working hours (but not simultaneously!), advertising on social networks (including YouTube), minimal rebranding, and cooperation with loyal partner companies for additional marketing.

Of course, the development of management decisions at PJSC «Lileia» during the nine months of 2020 is quite difficult. However, this is a very large enterprise, so such diversification of management decisions is quite natural.

The proposals developed in the study on the use of the neural network allow enterprise management to respond quickly to current threats and risks. In this case, effective management decisions and the reaction of the management system are recorded by the network, which provides its gradual learning. This situation leads to the improvement of management system of enterprise in general and ensures its economic security in particular. In this context, there are prospects for further research, namely the issue of balanced development of management systems from the standpoint of safe operation in a changing competitive market. In addition, it is necessary to note the relevance and usefulness of the proposed approaches for light industry enterprises in general, since the industry specificity was taken into account when forming the initial conditions for the functioning of the developed neural network. This approach allows enterprise management to improve both internal system processes and provide an appropriate response to typical threats.

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