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MODELS OF FINANCIAL CRISIS PREVENTION AT ENTERPRISES OF HOUSING AND COMMUNAL SERVICES

Methodical approach to the assessment, analysis and prevention of financial crisis at the enterprises of housing and communal services is proposed in the article. Adaptive models of forecasting the financial indicators, models of classification of financial situations and neuro-fuzzy models of crisis class identification are developed. Forecasted class of crisis of the enterprises of housing and communal services is determined considering the risk of changes in tariff policy.

Keywords: enterprises of housing and communal services, financial crisis, insolvency, threats accounts receivable, adaptive forecasting models, neuro-fuzzy models.

Тамара С. Клебанова, Лідія С. Гур'янова, Ольга О. Рудаченко МОДЕЛІ ПОПЕРЕДЖЕННЯ ФІНАНСОВИХ КРИЗ НА ПІДПРИЄМСТВАХ ЖИТЛОВО-КОМУНАЛЬНОГО ГОСПОДАРСТВА

Запропоновано методичний підхід до оцінки, аналізу та попередження фінансових криз на підприємствах житлово-комунального господарства. Розроблено адаптивні моделі прогнозування фінансових індикаторів, моделі класифікації фінансових ситуацій, нейро-нечіткі моделі ідентифікації класу кризи. Визначено прогнозований клас кризи підприємств житлово-комунального господарства з урахуванням ризику зміни тарифної політики.

Ключові слова: підприємства житлово-комунального господарства, фінансова криза, неплатоспроможність, загрози, дебіторська заборгованість, адаптивні моделі прогнозування, нейро-нечіткі моделі

Табл. 6, Рис. 4, Лит. 23

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Предложен методический подход к оценке, анализу и предупреждению финансовых кризисов на предприятиях жилищно-коммунального хозяйства. Разработаны адаптивные модели прогнозирования финансовых индикаторов, модели классификации финансовых ситуаций, нейро-нечеткие модели идентификации класса кризиса. Определен прогнозируемый класс кризиса предприятий жилищно-коммунального хозяйства с учетом риска изменения тарифной политики.

Ключевые слова: предприятия жилищно-коммунального хозяйства, финансовый кризис, неплатежеспособность, угрозы, дебиторская задолженность, адаптивные модели прогнозирования, нейро-нечеткие модели

Problem statement. In modern transformational economy Ukrainian enterprises including housing and community services (housing and utilities) are

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functioning under risk and uncertainty. Presence of outdated management and absence of new information technologies lead to crisis situations at the enterprises, especially in their financial activity. Lack of appropriate crisis leveling methods may cause great financial costs and, ultimately, leads to bankruptcy.

According to the Moratorium on bankruptcy of housing and utilities enterprises which carry out function of meeting immediate people's needs (the water supply, drainage, heat and gas supply) and have more than 50% of state ownership share cannot be liquidated. That's why bankruptcy of housing and utilities has a number of unique features. That requires implementation of new approaches to crisis management among which the most promising is preventive management. Applying the preventive approach and the complexity of the related problems cause the necessity of use of modern economic and mathematical tools for solving them, for support and substantiation of management decisions aimed at preventing crises in the financial and economic activities.

Literature Review. Analysis of the relevant literature showed that the problem of crisis assessment has been considered by many scientists. To date, developed economic and mathematical methods are successfully used for specific tasks of enterprises crisis assessment. The researches of such domestic scientists should be noted as M.Y. Adamiv, 2013; T.S. Klebanova, 2012; L.S. Guryanova, 2012; A.V. Matviychuk, 2013; I.G. Lukyanenko, 2004; R.O. Rudenskyi, 2009; O.M. Trydid, 2014. Moreover, it is important to mention such foreign scientists which raised the problem as R.J. Taffler, 1982; J. Minussi, 2003; J.A. Ohlson, 1980; A.A. Peresetskyi, 2007; W.H. Beaver, 1966; S.M. Berneti, 2011. However, it should be noted that most of the works devoted to the assessment of the crisis at enterprise are aimed at assessing the onset of bankruptcy, which is the final stage of the crisis at enterprise, while they have not reflected the preventive aspect of such assessment which should be carried out at the stage of potential or latent crisis. For the enterprises of housing and communal services, due to the Moratorium on bankruptcy, development of the tools of preventive financial control is of particular importance. All of this causes the topicality of the proposed research.

Unsolved parts of the problem. Applying the preventive approach and the complexity of the related problems cause the necessity of use of modern economic and mathematical tools for solving them, for support and substantiation of management decisions aimed at preventing crises in the financial and economic activities at housing and utilities enterprises.

Key results. Nowadays Ukrainian housing and utilities are characterized by volatile trends (T.S. Klebanova, Rudachenko O.O.), which subsequently could lead to the crisis in financial condition. This is due to a large depreciation of networks, of fixed assets, to a lack of funding from the state, to unprofitableness, high staff turnover, to rising costs of raw materials, shortage of own current assets, to a lack of advanced methods of management of housing and utilities enterprises etc. It should be noted that dramatic rise of housing and utility charges (particularly water and heat supply) at a constant minimum wage leads to social tension in individual regions and in the country as a whole. Regarding this, in the most of housing and utilities enterprises accounts receivable increase and accumulate primarily.

The proposed methodical approach to crisis assessment at housing and utilities is based on the principles of efficiency and preventive management. It allows determining the crisis class of analyzed and forecast period at the enterprises. The main stages of this approach are: selection of diagnostic indicators which characterize the financial situation of housing and utilities; determination of the current financial crisis class; determination of the forecast financial crisis class.

General interconnection scheme of such research objectives as assessment, analysis and prevention of crisis class at housing and utilities is presented on Figure 1.

The first stage is to determine groups of indicators which characterize housing and utilities financial situation. The results of the stage realization allow revealing crisis situation at enterprises. The first stage implementation provides the development of such research objectives as: forming the initial list of financial indicators, determining of representants in groups of financial indicators, forming the final list of the financial indicators.

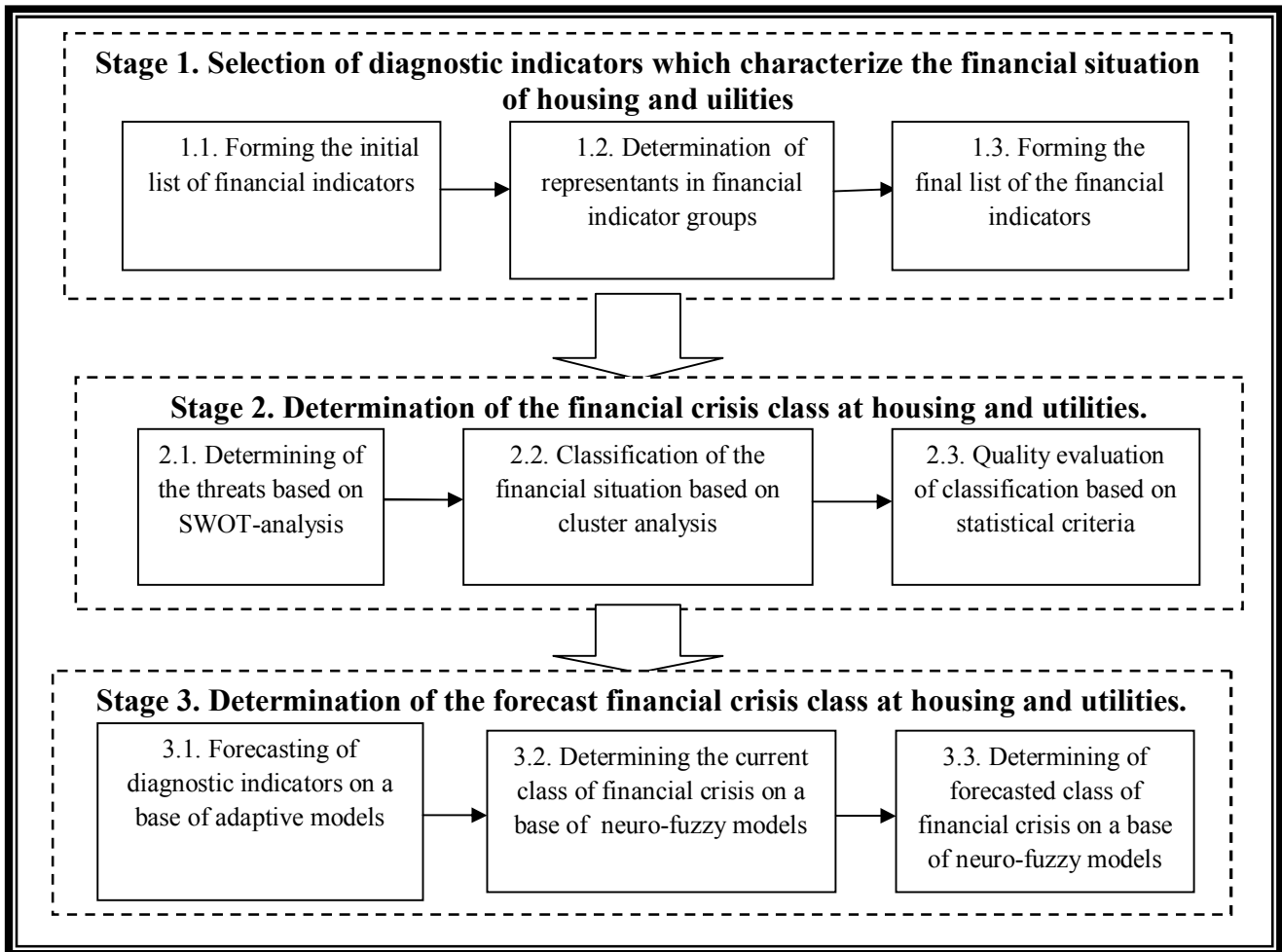


Figure 1. General interconnection scheme of assessment, analysis and prevention of crisis class at housing and utilities, authors' own construction

The matter of the second stage is to determine the financial crisis class at housing and utilities. The main objectives of this stage are determination of the threats, classification of financial situation based on cluster analysis, quality evaluation of classification.

The third and the last stage contains the forecasting of diagnostic indicators which characterize housing and utilities financial situation that make it possible to prevent possible change of crisis class in the short terms.

The implementation of the proposed methodical approach largely depends on the quality of the first stage realization. One of the stage components is selection of diagnostic indicators that allows assessing financial situation in current and forecast periods. Analysis of scientific publications showed the substantial difference of

opinions as for indicator groups and for number of indicators in each group (Klebanova T. S., Bondar O. M., Mozenkov O. V., 2003; Blank I. O., 2003; Ponomarenko V. S., Klebanova T. S., Kyzym M. O., 2013; Moroz O. V., Shvarts I. V., 2006; V. Pliuta, 1980; Soshnykova L. A., Tamashevych V. N., 1999).

The Guidelines for Identify Signs of Insolvency approved by the Ministry of Economy of Ukraine propose to analyze financial situation of the enterprises in terms of the five groups which contain 13 indicators. To reduce the number of indicators on the base of «the gravity center» method the representant indicators of each group were selected. These indicators are used for diagnosis and prevention of enterprises financial crisis. Among the diagnostic indicators are the quick ratio; financial independence ratio; proportion of funds in production; asset turnover ratio; ROE (return on equity).

SWOT-analysis based on selected diagnostic indicators allowed determining the list of the threats of financial crises for housing and utilities. It has been proved that increase in accounts receivable is one of the strongest threats arising from the population inability to pay the charges for public utility services (Rudachenko O.O., 2014; Klebanova T. S., Rudachenko O.O., 2015).

The result of analysis indicates that over 95% share of housing and utilities infrastructure is occupied by the two largest sub-sector: 1) water supply and sewage networks; 2) heat-power engineering. That is caused by high demand for these services and high energy capacity. So, the main stages of implementation of the proposed methodological approach was tested out at these enterprises.

The classification of financial situation of «Novovodolazke pidpriemstvo teplovykh merezh» (Heating Networks Enterprise in Nova Vodolaha) was realized on a base of cluster analysis, particularly of Ward's method. The enterprise provides services of district heating for Kharkiv region consumers. The results of classification are illustrated on Figure 2.

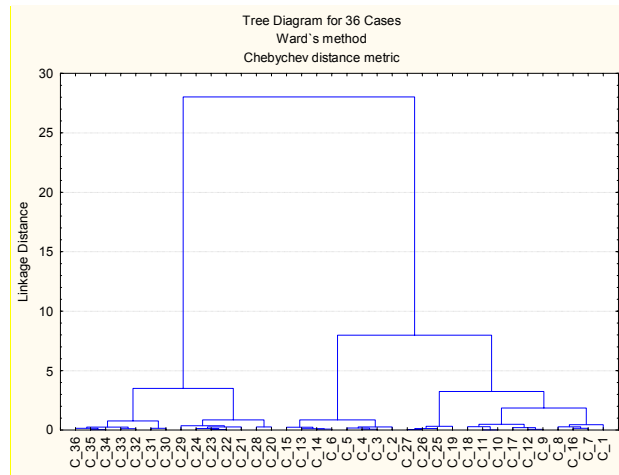


Figure 2. Tree diagram for Ward’s method classification, authors’ own construction based on implementation of Statsoft Statistica 6

The analysis of the results shows that the first cluster contains the crisis financial situations, the second cluster contains unstable financial situations, and the third cluster contains stable financial situations. The following Table 1 describes the interpretation of the classes.

Table 1. The interpretation of the classes of financial crisis, authors’ own development

Cluster number	Interpretation of the class	Description
1	Crisis financial situation	Enterprises of this class have low liquidity, financial stability and profitability. Representant indicators defining liquidity and financial independence were lower than standard in most cases. That indicates poor financial solvency and unsatisfactory financial stability of cluster enterprises. The most problematic aspects of the third-class enterprises are significant receivables and payables leading to the losses in most cases.
2	Unstable financial situation	Enterprises of this class don’t have high liquidity, financial stability, profitability and business activity. That indicates the low quality of the enterprises financial management
3	Stable financial situation	Enterprises of this class have a slight increase in representant indicators of each group: property rates; liquidity; financial stability; business activity; profitability.

For proving the hypothesis of the three clusters, obtained by Ward’s method, the clustering was held on a base of K-means method.

The following Figure 3 illustrates plot of diagnostic indicators means for each cluster obtained by the K-means method. The diagnostic indicators means indicate a considerable difference between classes. That confirms again the high quality of the

resulting classification. A similar clustering of financial situations at several other housing and utilities also confirms obtaining three classes of crisis financial situations.

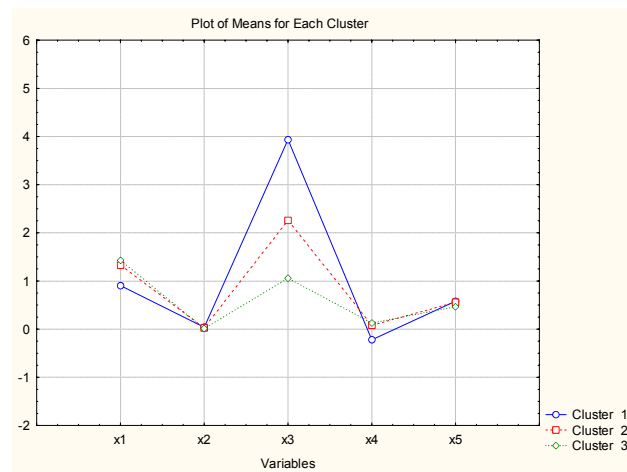


Figure 3. Plot of diagnostic indicators means for each cluster, authors' own construction based on implementation of Statsoft Statistica 6

One of the proposed approach objectives is forecasting of diagnostic indicators on a base of trend and adaptive models. However, the results of forecasting trend-models has an error far more than 10%. That confirms the irrationality of implementation of these models. Therefore, the adaptive models were used for further research. Minimum of mean absolute percentage error (m.a.p.e) was used as a criteria of optimality for adaptation parameter selection in forecasting (Rudachenko O.O., 2014).

The results of the research helped to define the model with the smallest percentage error for each diagnostic indicator of financial activity of the enterprises (Table 2).

Table 2. Selection of forecasting adaptive models for diagnostic indicators of financial activity of the enterprises, authors' own calculation

Indicator	Model	M.a.p.e.
«Novovodolazke pidpriemstvo teplovykh merezh» (Heating Networks Enterprise in Nova Vodolaha)		
The quick ratio	Fading trend	4,233%
Proportion of funds in production	Fading trend	6,998%
Asset turnover ratio	Exponential trend	7,043%
ROE	Fading trend	6,201%
Financial independence ratio	Fading trend	6,600%

Table 2. Selection of forecasting adaptive models for diagnostic indicators of financial activity of the enterprises, authors' own calculation

«Novovodolazke vodoprovidno-kanalizatsiine pidpriemstvo» (Water and Sewage Enterprise in Nova Vodolaha)		
The quick ratio	Fading trend	8,542%
Proportion of funds in production	Fading trend	7,755%
Asset turnover ratio	Fading trend	7,599%
ROE	Fading trend	8,015%
Financial independence ratio	Fading trend	7,699%

The financial crisis class of current and forecast period was determined on a base of modern neuro-fuzzy models, which are the generalization of classical set theory and classical formal logic (Leonenkov O. V., 2005; Matviychuk A.V., 2013; Tsmots O. I., Tsymbal Iu. V., Tsmots I. H., 2012; Shtovba S. D., 2007). The structure of neuro-fuzzy network corresponds to the main blocks of fuzzy system. The main difference between neural network and other techniques is that neural models can be built on the base of proposed information. That is the reason of widespread implementation of neural network in developing of unformalized objectives with hard algorithmization. Input indicators of neuro-fuzzy model are five diagnostic indicators, and output indicator is characteristic which determine the financial crisis class (Table 3).

Table 3. Range of financial crisis class values, authors' development

Cluster number	Range of values	Class interpretation
1	0-1	Crisis financial situation
2	1-2	Unstable financial situation
3	2-3	Stable financial situation

The structure of fuzzy neural network which is based on 2012-2014 statistics of «Novovodolazke pidpriemstvo teplovykh merezh» (Heating Networks Enterprise in Nova Vodolaha) is illustrated on Figure 4. Verification of neuro-fuzzy models based on mean absolute percentage error showed an excellent quality of crisis classes recognition. The residual was about 0,068%.

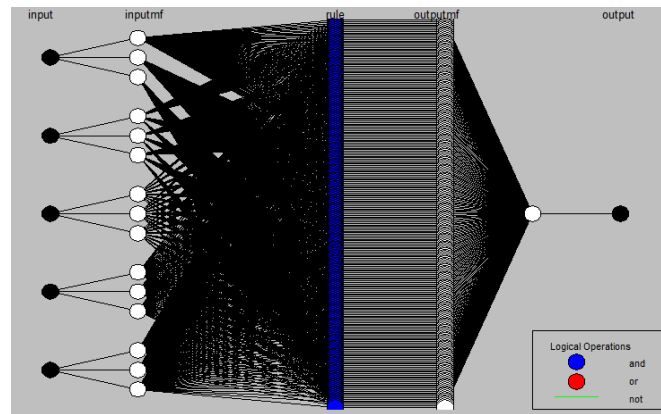


Figure 4. The structure of fuzzy neural network, authors' own construction based on implementation of Statsoft Statistica Neural Networks

Determining of the current financial crisis class on a base of fuzzy neural network led to the following conclusions: from the first quarter of 2012 to the second quarter of 2013 the financial condition of «Novovodolazke pidpriemstvo teplovykh merezh» (Heating Networks Enterprise in Nova Vodolaha) was identified as being in stable financial situation, in 2014 it became worse.

The proposed model basis was approbated on several housing and utilities of Kharkiv region. The results of determining the financial crisis at these enterprises are demonstrated in Table 4.

Table 4. Financial crisis classes at housing and utilities of Kharkiv region, authors' own calculation based on enterprises financial reporting and neuro-fuzzy model implementation

Name of Enterprise	Proportion of funds in production	The quick ratio	Financial independence ratio	Asset turnover ratio	ROE	Crisis class
2012						
KP «Kharkivvodokanal» (Kharkiv Water Utility)	0,070	1,335	0,586	0,558	-0,156	2,1452
KP «Kharkivski teplovi merezhi» (Kharkiv Heating Networks)	0,031	0,633	0,024	0,071	-0,535	1,9586
SKP "Kharkivzelenbud"	0,284	0,804	0,912	0,273	0,027	2,0521
KP «Zhovtneve tramvaine depo» (Tram Depot in Zhovtneve)	0,398	0,493	0,620	2,250	0,104	0,8852

Table 4. Financial crisis classes at housing and utilities of Kharkiv region, authors' own calculation based on enterprises financial reporting and neuro-fuzzy model implementation

2013						
KP «Kharkivvodokanal» (Kharkiv Water Utility)	0,069	1,149	0,533	0,558	-0,189	2,1120
KP «Kharkivski teplovi merezhi» (Kharkiv Heating Networks)	0,024	0,449	0,135	0,710	-0,453	1,9002
SKP "Kharkivzelenbud"	0,399	0,598	0,919	0,217	0,040	1,9450
KP «Zhovtneve tramvaine depo» (Tram Depot in Zhovtneve)	0,012	1,006	0,136	1,457	0,091	0,9131
2014						
KP «Kharkivvodokanal» (Kharkiv Water Utility)	0,035	0,586	0,272	0,285	-0,096	2,0245
KP «Kharkivski teplovi merezhi» (Kharkiv Heating Networks)	0,025	0,092	0,028	0,441	-0,305	1,8745
SKP "Kharkivzelenbud"	0,282	0,498	0,949	0,148	0,035	2,1634
KP «Zhovtneve tramvaine depo» (Tram Depot in Zhovtneve)	0,010	0,953	0,078	0,316	0,071	0,8836

According to Table 4 Kharkiv housing and utilities financial conditions are classified as unstable.

The following Table 5 presents determining of the forecast financial crisis class on a base of diagnostic indicators of enterprises financial activity at housing and utilities in city-like settlement Nova Vodolaha.

Table 5. Determining of the forecast financial crisis class of Kharkiv region housing and utilities, authors' own calculation based on enterprises financial reporting and neuro-fuzzy model implementation

Period	The quick ratio	Proportion of funds in production	Asset turnover ratio	ROE	Financial independence ratio	Crisis class
«Novovodolazke pidpryiemstvo teplovykh merezh» (Heating Networks Enterprise in Nova Vodolaha)						
June 2015	0,841	0,040	5,059	- 0,466	0,761	1,061
«Novovodolazke vodoprovvidno-kanalizatsiine pidpryiemstvo» (Water and Sewage Enterprise in Nova Vodolaha)						
June 2015	0,247	0,131	0,803	- 0,015	0,173	2,995

Forecasted financial situation of «Novovodolazke pidpryiemstvo teplovykh merezh» (Heating Networks Enterprise in Nova Vodolaha) showed a possible changing into crisis class because in this period the output value is 1,061. The forecasting results indicate that management should implement anti-crisis measures.

Threats determination is one of the important objectives of the proposed methodological approach (see Figure 1) for housing and utilities. Based on the analysis it has been determined that receivables growth is one of the strongest threats for housing and utilities. Receivables accumulation demonstrates the population inability to pay the charges for public utility services.

The complex of models assessing the impact of the receivables growth on the financial crisis formation was developed. Diagnostic indicators of housing and utilities financial activity, the enterprises receivables and the income of the same region population were forecasted to determine the increasing of enterprises receivables. The results were used for forecasting the financial crisis class on a base of neuro-fuzzy models.

The complex of models was tested out at «Novovodolazke vodoprovvidno-kanalizatsiine pidpryiemstvo» (Water and Sewage Enterprise in Nova Vodolaha). The results of determined forecasted financial crisis class are presented in Table 6.

Table 6. Determining of the forecast financial crisis class considering the risk of changing of tariff policy, authors' own calculation based on enterprises financial reporting and neuro-fuzzy model implementation

Period	The quick ratio	Proportion of funds in production	Asset turnover ratio	ROE	Financial independence ratio	Crisis class
June 2015	0,006	0,49	0,45	-0,002	0,068	2

The Table 6 shows the forecast indicators have been deteriorated in a result of housing and communal service charges growing. That caused to deterioration of the financial crises class.

So, increased government tariffs for the population lead to a number of negative trends related to the insolvency of the population. Particularly that leads to increasing and accumulation of receivable and payable accounts, to deterioration of profitability and other financial indicators and eventually to enterprises losses that turn into deterioration of the financial crises class.

Conclusions. Consequently, implementation of crises assessment models enables to develop the following objectives. First of all, the reduced system of diagnostic indicators which was used for operative assessment of enterprises crisis was developed. Secondly, the classification of financial crisis at housing and utilities was formed that make it possible to track the trend of industry development. Thirdly, the enterprises financial crises assessment depending on the dominant threats of current and forecast periods was conducted. The assessment allows preventing the financial crisis emergence and timely developing the preventive measures to minimize losses of housing and utilities.

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