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**MANAGEMENT OF ENTERPRISE FINANCIAL SECURITY
AND ITS INTELLECTUAL COMPONENT BASED ON CREATING
MULTIAGENT DECISION SUPPORT SYSTEM**

The use of collective decision-making system in management of enterprise financial security and its intellectual component are considered. The stages of management of business entities financial security are proposed. The ontological models for management of enterprise financial and intellectual security on the basis of multiagent approach are developed in the "Protege" environment.

Keywords: financial security; intellectual security; ontological model; multiagent system; intelligent agent.

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УПРАВЛІННЯ ФІНАНСОВОЮ БЕЗПЕКОЮ ПІДПРИЄМСТВА
ТА ЇЇ ІНТЕЛЕКТУАЛЬНОЮ СКЛАДОВОЮ НА ОСНОВІ
ФОРМУВАННЯ МУЛЬТИАГЕНТНОЇ СИСТЕМИ ПРИЙНЯТТЯ
РІШЕНЬ**

У статті розглянуто питання використання систем колективного прийняття рішень для дослідження управління фінансовою безпекою підприємства та її інтелектуальної складової. Запропоновано етапи організації управління фінансовою безпекою суб'єктів підприємництва. Розроблено онтологічні моделі для системи управління фінансовою та інтелектуальною безпекою суб'єктів підприємництва на основі мультиагентного підходу в середовищі "Protege".

Ключові слова: фінансова безпека; інтелектуальна безпека; онтологічна модель; мультиагентна система; інтелектуальний агент.

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УПРАВЛЕНИЕ ФИНАНСОВОЙ БЕЗОПАСНОСТЬЮ
ПРЕДПРИЯТИЯ И ЕЕ ИНТЕЛЛЕКТУАЛЬНОЙ СОСТАВЛЯЮЩЕЙ
НА ОСНОВЕ ФОРМИРОВАНИЯ МУЛЬТИАГЕНТНОЙ СИСТЕМЫ
ПРИНЯТИЯ РЕШЕНИЙ**

В статье рассмотрены вопросы использования систем коллективного принятия решений для исследования управления финансовой безопасностью предприятия и ее интеллектуальной составляющей. Предложены этапы организации управления финансовой безопасностью субъектов предпринимательства. Разработаны онтологические модели для системы управления финансовой и интеллектуальной безопасностью субъектов предпринимательства на основе мультиагентного подхода в среде "Protege".

Ключевые слова: финансовая безопасность; интеллектуальная безопасность; онтологическая модель; мультиагентная система; интеллектуальный агент.

Problem statement

A number of studies has been dedicated to the threats to enterprise financial security and its intellectual component changing in a response to increased environment turbulence. Multidimensionality of enterprise financial security is caused by the

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variety of its components. In this aspect of enterprise financial security, large data arrays from wide range of sources should be monitored and centers of databases and decision making should be shared between different structural units.

Thus, the use of new financial security management tools that develop behavior patterns to react to the threats for all decision makers becomes critical. An approach should be developed to build a decision support system (DSS) on the basis of multi-agent models which organize and coordinate interaction of individual agents that process information from different data sources and produce collective justifiable sound management decisions.

Literature review

Enterprise financial security has been studied by O. Arefieva (2009), I. Blank (2009), M. Yermoshenko & K. Goryacheva (2010), A. Yepifanov (2009), N. Grynyuk (2008), T. Zahorelska (2006), Kartuzov Y. (2012), Y. Kim (2009), L. Mandru (2010), A. Khashman (2010), L. Matviychuk (2011), I. Moyseenko (2011), L. Petrenko (2010), M. Pogosova (2010) etc. The analysis of scientific works demonstrated significant differences in the approaches to diagnosing financial security, its components and indicators of threats.

Research objective

The issues of distributed and coordinated multilevel management system of enterprise financial security were uncovered by scientists despite a number of studies devoted to enterprise financial security.

The goal of this article is to develop a model of collective decision-making on management of financial security in general and intellectual security in particular based on the multiagent approach. This approach would solve the multifactor task of ensuring financial security within the distribution of management functions and accumulation of information centers monitoring. The set of decision management solutions of financial security can be identified with the abovementioned agent system.

Presentation of the research material, including methodology description and key research findings

Management of financial security is organically included in the overall system security management of the enterprise and is one of its main functional subsystems that ensures the implementation of management solutions primarily in the financial sector of operations (Zahorelskaya, 2006). A major factor in ensuring financial security is effective financial and economic activity of a company in today's economy. It is impossible without human, customer and structural capital, which are the components of intellectual capital (Zhuravleva, 2013). Therefore, enterprise intellectual security is one of the key components of financial security (Cherep, 2012). Location of financial security management and its intellectual component in the overall hierarchical enterprise management system is presented on Figure 1.

Analysis of the literature allowed reaching the conclusion that organization of enterprise financial security has a certain consistency.

Stage 1. Monitoring of financial security. Implementation of this measure involves collection, analysis, evaluation and prediction values of indicators of enterprise financial condition. Deviations of financial indicators from their targets and forecast values indicate the threatening effect of internal and external factors.

Normative values of parameters should be set according to specificity and magnitude of an enterprise. The size of deviations of the indicators needs to identify the factors that influence it, and the development of appropriate management solutions. Monitoring of factors that affect financial security allow predicting possible development of enterprises based on current trends in the dynamics of performance indicator, identify potential threats and prevent them.

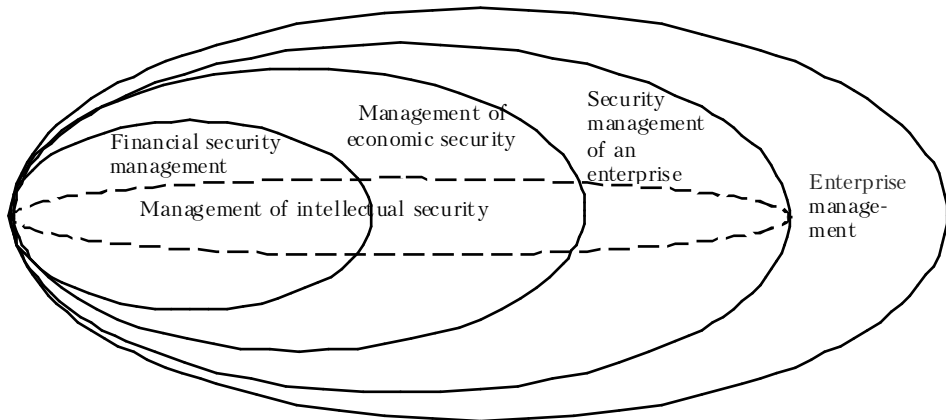


Figure 1. Location of financial security management in the general hierarchical management system of business entity, authors

The literature review showed that the most important in assessing financial security of a company are the following groups of indicators: property status (depreciation reserve ratio, retirement / disposal of fixed assets) (Yepifanov, 2009; Mandru, 2010), liquidity ratios (current ratio, cash ratio, receivables to payables ratio, general liquidity ratio) (Arefieva, 2009; Kim, 2009; Moiseenko, 2011; Pogosova, 2010; Yepifanov, 2009), capital structure (equity ratio, current assets to equity ratio, equity/debt ratio, financial leverage ratio) (Arefieva, 2009; Yermoshenko, 2010; Kim, 2009; Moiseenko, 2011; Pogosova, 2010; Yepifanov, 2009), turnover ratios (inventory turnover, receivables turnover ratio, accounts payable turnover, asset turnover ratio, equity turnover ratio, fixed assets turnover) (Yermoshenko, 2010; Kim, 2009; Moiseenko, 2011; Pogosova, 2010; Yepifanov, 2009), profitability ratios (return on assets (ROA), return on equity (ROE), return on goods sold, return on sales (ROS)) (Arefieva, 2009; Yermoshenko, 2010; Kim, 2009; Moiseenko, 2011; Pogosova, 2010; Mandru, 2010; Yepifanov, 2009).

Stage 2. Definition of strategies and measures to prevent the action of threats to enterprise financial security. Determination the ability of the enterprise to counteract threats on the basis of strategic analysis, evaluating the ability of companies to accumulate their own and borrowed resources to prevent crises, develop and evaluate measures aimed at leveling risks and threats to financial security during this stage (Slizkaya, 2007).

Stage 3. The implementation of strategies and measures to prevent and neutralize threats of internal and external environment on the level of financial security. Levelling of the factors surrounding the enterprise provides high-quality decision-making based on the results of monitoring of the existing level of financial security.

Management of enterprise financial security aims to ensure the protection of major financial interests from external and internal threats, based on the system of principles and methods for developing and implementing management decisions not only on the experience of senior managers of units, but also through the use of automated tools of economic and mathematical modelling (Petrenko, 2010). Multiagent system (MAS) is proposed to be used as a tool for financial security management.

The term "multiagent system" (MAS) is applied to a number of software systems that consist of autonomous and semi-autonomous components and are used in various fields of activity (Vidal, 2007). This system is characterized by the following properties (Shevtsov): situational – the ability to perceive environment and work in this environment, with the possibility of changing it for own purposes; autonomy – the ability to interact with environment without the direct involvement of other agents; flexibility and sociality; flexibility – the ability to demonstrate sensitivity to quality or predictability; sociality – the ability to appropriately interact with other software or human agents.

Management system of financial security seems to set hierarchically interrelated and interdependent elements that reflect the contents of certain priority processes of business entity at a moment (Grynyuk, 2008). These are the elements in mass intelligent agents. Intelligent agent (IA) is a software or hardware object (entity), autonomously functioning to achieve the objectives set for the user who has certain intellectual abilities. The basis of any intelligent agent is its knowledge base, the core of which is ontology (Darevych, 2005). Ontology defines common properties of IA and sets the way of knowledge representation and reasoning mechanisms of decision-making (Lytvyn, 2009). It is a logical model that describes the study of domain knowledge and the relationships between its concepts and objects. Definition of complex concepts can be formed on the basis of a simple definition and with the use of operator in the environment of building ontologies. Building of ontological models allows taking into account all the links between objects of financial security management, to form the corresponding pattern by which it becomes possible to meet the challenges of diagnosing threats and the emergence of prompt and timely solutions to prevent them in management of business entities financial security based on the results of monitoring.

Association of agents to solve collectively the problems of enterprise financial security management provides their collective behavior in MAS. Agents, which will act as managers of different business units, i.e. decision makers (DM), can interact with each other in solving individual problems in case of difficulties. Algorithm for collective decision-making aims at the implementation of each stage of the process by a group of specified agents. The output (results) operations of previous groups of agents are inputs for following decision-making (Kovalenko, 2011).

Basic knowledge is required and is a traditional component of all intelligent systems. Agent can seek the assistance of other agents, if unable to solve its task on the basis of their basic knowledge in multiagent systems. This type of system is distributed and ensures collectivity of decision-making by creating a group.

Simulation of financial security system on the basis of multiagent model provides a detailed description of object, qualitative analysis and prediction of its dynamic characteristics, and is a prerequisite for efficient and flexible management policies to

adapt to changing environmental conditions. Such management system that can be used to support decision-making under multicriteria selection formed a large number of indicators and data that must be considered. This involves the formation of effective solutions based on processing large volumes of information that necessitates the use of appropriate automated application that will allow simultaneously consider all the criteria required for a secure financial situation of the company. Control system provides an optimized search for the best solution from the set of possible ones and organizes them benefitally (System of decision-making support ..., no date). It is an intellectual form of a company's global behavior to ensure their financial security on the basis of managers' decisions from various structural elements of enterprise and contribute to the evaluation of quality economic and technical-organizational measures based on relevant indicators in financial security management. The agents in such a system are the managers of various departments of an enterprise that have specific knowledge required for the organization of activities to prevent and level the factors that affect company' financial security.

It is advisable to take into account not only the indicators of financial security for building multiagent system model of decision-making, but also hierarchically organized threats, objectives and strategies of an enterprise to implement them, which are exposed to dangerous factors. Multiagent system that will promote operational implementation of management decisions for financial security management can be described by the following set of interrelated elements:

$$M = (Exp, Index, Goals, Int, F_int, F_Ext, Dec), \quad (1)$$

where *Exp* – agents-experts (decision makers), *Index* – indicators, *Goals* – goals of the enterprise strategies to ensure financial security, *Int* – the interests of the of business entity, *F_int* – factors of enterprise internal environment, *F_extG* – macro factors, *F_Ext* – meso-level factors, *Dec* – strategies (decision).

Composition tuple of MAS objects was chosen based on the analysis of studies (Yermoshenko, 2010; Moiseenko, 2011). As indicators that assess financial security of business entity are used the groups of property status, liquidity, capital structure, turnover and profitability ratios. Most significant indicators in each group were selected based on the analysis of scientific results for building ontologies. Enterprise internal factors that affect business entities' financial security were studied in detail.

The main financial interests of an enterprise are chosen to ensure financial security: increase of the market value of business entity, profit maximization, optimal capital structure, innovative software and optimization of tax deductions (Yermoshenko, 2010). The developed ontological model of enterprise financial security is presented on Figure 2.

As indicators that assess intellectual security of a business entity we use gross margin per unit of output, equity ratio, return on equity (ROE), equity turnover ratio, the amount of intellectual capital, return on assets (ROA), the share of innovative products, gross margin, the share of intangible assets in total assets, gross profit / intangibles, gross profit / wages and salaries, value added intellectual coefficient (VAIC), structural capital efficiency (SCE) (gross profit/investments in informatization), competitive capital efficiency (CCE) (capital labour ratio, provision of equity per employee, provision of debt per employee, the share of employees with higher

education in the total number of employees, the share of employees who improved their qualification in the total number of employees, the share of employees who received a new profession in the total number of employees, the share of pensioners, gross profit/costs on R&D, gross income/costs of education, health, gross profit/costs of training), consumer capital efficiency (CCE) (receivables and payables ratio, accounts receivables turnover, finished goods turnover ratio).

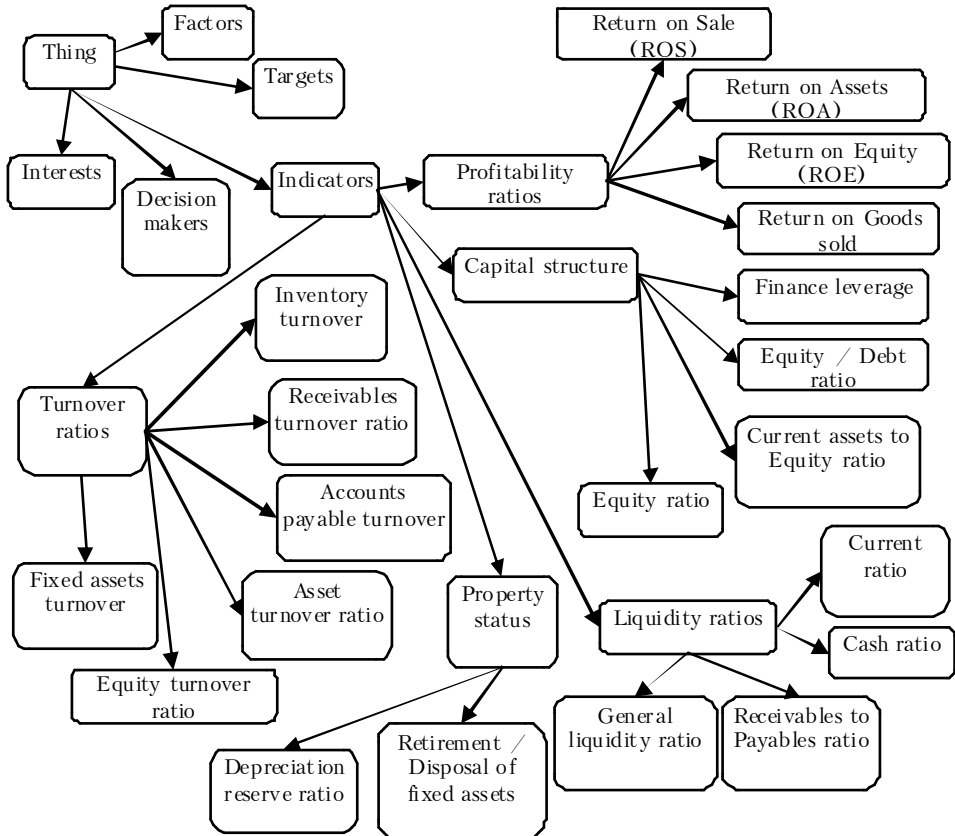


Figure 2. The ontological management model of enterprise financial security developed within the "Protege" environment, authors

The increase in the market value of a business entity, the quality of earnings and optimal capital structure based on intellectual component were selected as the major financial interests of the enterprise in terms of the creation and use of intellectual capital. The developed ontological model of enterprise intellectual security is presented on Figure 3.

Conclusions and further research perspectives

Managerial decision-making to ensure financial security of a business entity is complicated by the influence of a large number of threats for internal and external environment, the variability of its environment, distribution of decision-making to provide financial security among managers at different levels. The constructed man-

agement system of enterprise financial security based on the MAS can be a tool for timely diagnosis of environmental factors through a set of performance indicators, the prevention and reduction of factors that destabilize the financial position of an enterprise on the basis of consolidated and collective decision-making.

The ontological model of the considered system of enterprise financial security developed on the basis of systematization factors macro-, meso- and micro-levels that affect financial security.

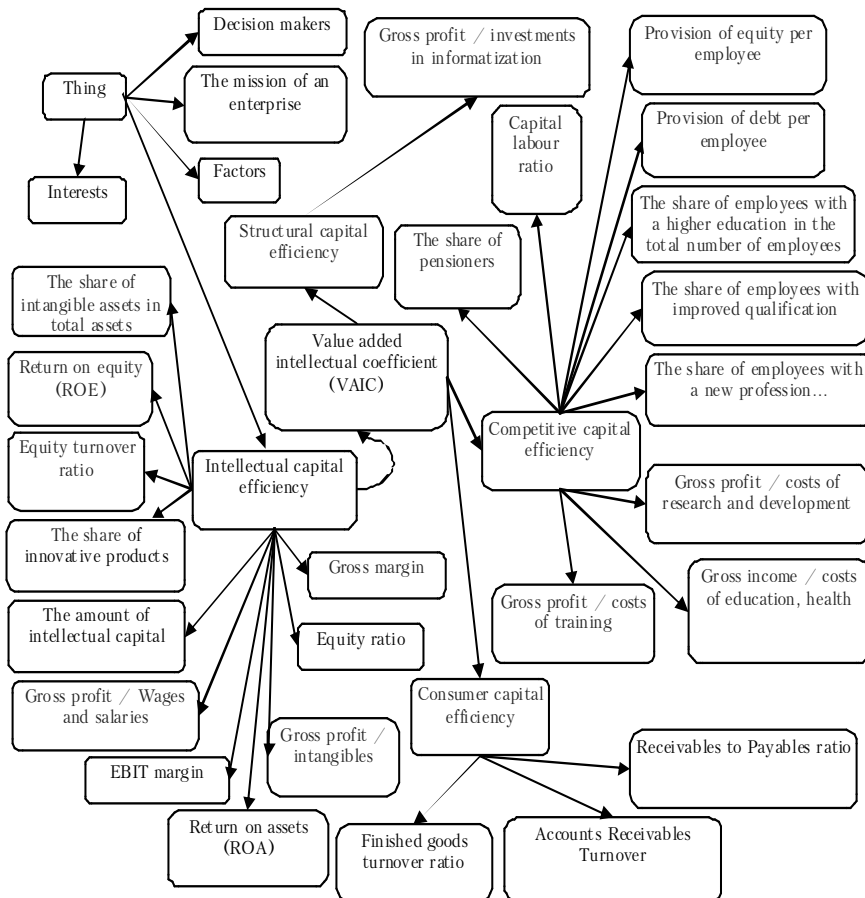


Figure 3. The ontological management model of enterprise intellectual security developed within the "Protege" environment, authors

This model takes into account the factors and objectives of the strategy of financial entities, uses semantic structure of knowledge about enterprise environment, allowing to perceive multidimensional environment and act in it, adapting to a situation, monitor the status of financial security and choose an appropriate development strategy. The lack of research on the characteristics of the use of the system of enterprise financial security determines the need for further development of the research on the issue to expand the structure of the proposed ontological management model of financial and intellectual security.

References:

- Ареф'єва О.В.* Економічні основи формування фінансової складової економічної безпеки / О.В. Ареф'єва, Т.Б. Кузенко // Актуальні проблеми економіки. – 2009. – №1. – С. 98–103.
- Бланк И.А.* Управление финансовой безопасностью предприятия / И.А. Бланк. – Киев: Эльга, 2009. – 778 с.
- Гринюк Н.А.* Методичні підходи до обґрунтування індикаторів оцінки рівня фінансової безпеки підприємства / Н. А. Гринюк // Проблеми науки. – 2008. – №6. – С. 35–40.
- Даревич Р.Р.* Метод автоматичного визначення інформаційної ваги понять в онтології бази знань / Р.Р. Даревич, Д.Г. Досин, В.В. Литвин // Відбір та обробка інформації. – 2005. – №.22. – С. 105–111.
- Єрмошенко М.М.* Фінансова складова економічної безпеки: держава і підприємство [Текст] : Наук. моногр. / Єрмошенко М.М., Горячева К.С. – К.: Нац. акад. упр., 2010. – 231 с.
- Журавльова І.В.* Емпіричний аналіз впливу процесів функціонування інтелектуального капіталу на результати діяльності підприємств / І.В. Журавльова // Актуальні проблеми економіки. – 2013. – № . – С. 119–127.
- Загорельская Т.Ю.* Финансовая безопасность как объект управления / Т. Ю. Загорельская // Наук. праці ДНТУ. – 2006. – №103–4. – С. 215–218.
- Картузов Є.П.* Визначення фінансової безпеки підприємства: поняття, зміст, значення і функціональні аспекти / Є.П. Картузов // Актуальні проблеми економіки. – 2013. – №8. – С. 172–181.
- Кім Ю.Г.* Управління системою фінансової безпеки підприємства : автореф. дис... канд. екон. наук за спец. 21.04.02 – "Економічна безпека суб'єктів господарської діяльності" / Ю.Г. Кім. – Київ, 2009. – 25 с.
- Коваленко О.Є.* Мультиагентна модель колективного прийняття рішень / О.Є. Коваленко // Математичні методи, моделі та інформаційні технології в економіці. – 2011. – №11. – С. 279–285.
- Литвин В.В.* Мультиагентні системи підтримки прийняття рішень, що базуються на прецедентах та використовують адаптивні онтології / В.В. Литвин // Искусственный интеллект. – 2009. – №2. – С. 24–33.
- Матвійчук Л.О.* Методика визначення рівня фінансової безпеки машинобудівних підприємств / Л.О. Матвійчук // Актуальні проблеми економіки. – 2011. – №5. – С. 109–114.
- Мойсеєнко І.П.* Управління фінансово-економічною безпекою підприємства / І.П. Мойсеєнко, О.М. Марченко. – Львів, 2011. – 380 с.
- Петренко Л.М.* Моделювання процесів управління фінансовою безпекою підприємства: автореф. дис... канд. екон. наук: 08.00.11 / Л.М. Петренко; ДВНЗ "Київ. нац. екон. ун-т ім. В. Гетьмана". – К., 2010. – 19 с.
- Погосова М.Ю.* Діагностування фінансової безпеки промислового підприємства: автореф. дис... канд. екон. наук: 08.00.08 / М. Ю. Погосова; Ун-т банк. справи Нац. банку України. – К.: 2010. – 20 с.
- Слизкая В.П.* Управление финансовой безопасностью предприятия в условиях нестабильности [Web resource] / В.П. Слизкая // Проблемы современной экономики. – №4. – 2007. – URL: <http://www.m-economy.ru/art.php?nArtId=1761>.
- Система поддержки принятия решений [Web resource]. – URL: http://www.oviont.com/soft/tools/sppr/sppr_expan.php.
- Фінансова безпека підприємств і банківських установ : монографія / за заг. редакцією д-ра екон. наук, проф. А.О. Єпіфанова [А.О. Єпіфанов, О.Л. Пластун, В.С. Домбровський та ін]. – Суми: ДВНЗ "УАБС НБУ", 2009. – 295 с.
- Череп О.Г.* Інтелектуальний капітал як об'єкт забезпечення фінансової безпеки // Теоретичні та практичні аспекти економіки та інтелектуальної власності. – 2012. – Вип. 1. – Т 3. – С. 309–311.
- Швецов А.Н.* Агентно-ориентированные системы: от формальных моделей к промышленным приложениям [Web resource] / Швецов А.Н. – URL: www.ict.edu.ru/ft/005656/62333e1-st20.pdf.
- Bordeianu, G.-D., Radu, F., Parashivescu, M.D., Pavaoia, W.* (2011). Analysis models of the bankruptcy risk. *Economy Transdisciplinarity Cognition*, Vol. XIV, Issue 1/2011, P. 248–259.
- Mandru, L., Khashman, A., Carstea, C., David, N., Patrascu, L.* (2010). The Diagnosis of Bankruptcy Risk Using Score Function. *Recent advances in artificial intelligence, knowledge engineering and data bases*, P. 83–87.
- Vidal J.M.* (2007). *Fundamentals of Multiagent Systems*. [Web resource], URL: jmvidal.cse.sc.edu/library/vidalfmas.pdf.

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