providing users with a unique experience of interacting with historical heritage. Using Notion Space to organize collaborative work enables effective interaction between distributed teams and experts, improving development processes and knowledge sharing. The proposed research integrates technology, art and education, providing a unique platform for visual engagement with cultural heritage and history.

Keywords: *artificial intelligence, virtual panoramas, heritage, interaction, augmented reality.*

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DEVELOPMENT OF AN INFORMATION SYSTEM FOR INTEGRAL RATING ASSESSMENT OF INVESTMENT ATTRACTIVENESS OF AN ENTERPRISE

Abstract. *Numerous methods of financial diagnostics of business entities have been analyzed in this article, methodological approaches to integral assessment have been considered. A study of methods of rating assessment of enterprise activity by different methods was carried out.*
Emphasis on the integrated assessment of the enterprise was placed. The use of the Harrington's desirability function to build a generalized indicator of investment attractiveness of an enterprise was proposed. An economic-mathematical model of rating assessment has been developed, the use of which allows: to determine the indicators for assessing the investment attractiveness of economic entities to obtain their ratings; to calculate normalized indicators of investment attractiveness, if necessary; to calculate the integral indicator of investment attractiveness. To test the adequacy of the model, an experiment was conducted, which confirmed the adequate representation of the integrated indicator depending on the input data. The rating process was automated by creating an information system that allows determining an integrated assessment of the investment attractiveness

of an enterprise, taking into account its components. The results obtained in this way allow making decisions on the level of efficiency of certain enterprises, and the developed automated system increases the level of information support in monitoring the overall assessment of the enterprise.

Keywords: *rating, integrated assessment, investment attractiveness, financial diagnostics, information system, automation.*

INTRODUCTION

The need to study the rating assessment of business entities, regions, and the state is due to the extreme relevance of ratings as an information source for making management decisions. The rapid spread of ratings as a tool for assessing the investment attractiveness and competitiveness of companies was a reaction to the increasing level of financial risks and the growing number of financially insolvent enterprises.

Today, the world is witnessing a growing level of distrust in the ratings of countries, enterprises, organizations, brands, trademarks, etc. published by specialized institutions. It is worth noting that ratings have largely become objects of manipulation, they are increasingly custom-made, formed under the influence of interested parties (owners and managers of enterprises, public authorities, lobbyists, etc.).

These problems were most clearly outlined during the global financial and economic crisis, when the high rating results of a number of global industrial giants proved to be biased, which, on the one hand, did not allow to foresee the threat of bankruptcy of these enterprises, and on the other hand, called into question the feasibility of rating assessment by specialized agencies in today's conditions. This situation is primarily due to the non-transparency and unclear methodological support of rating procedures, which makes it impossible to track the parameters and tools used to form rating lists.

In such circumstances, an important task is to form a sound and unified scientific and theoretical basis in order to improve and develop the methodological and applied principles of rating, in particular, in the direction of systematizing and structuring rating assessment methods depending on the external and internal conditions of the studied business entities, as well as the use of modern computer technologies to implement the proposed approaches. Therefore, it can be argued that the proposed research topic is relevant and in demand.

REVIEW OF PREVIOUS WORKS

Numerous methods of financial diagnostics of business entities are used in analytical practice. At the same time, the diversity and variety of existing methods does not ensure unity, comparability and comparability of assessment results and, to some extent, allows for their manipulation. In this context, it is worth exploring the feasibility of using a rating system as an alternative to economic analysis and traditional domestic methods of financial diagnostics of enterprises [1–6].

The range of methodological approaches to integrated assessment is quite wide. However, some methods (cluster analysis, scoring analysis), in our opinion, do not provide an adequate comprehensive assessment of the financial condition of the company. The method of comparative rating assessment and the method of rating financial analysis are more thorough. However, the comparative rating assessment is aimed at comparing the performance of the enterprise under study with the best enterprise in the sample. A significant disadvantage of this approach is the neglect of adjusting individual indicators by weighting coefficients that would reflect the degree of their impact on the final result. Rating financial analysis, on the contrary, takes into account the degree of influence of indicators, but neglects comparison in space, i.e. with the rest of the enterprises in the industry or region.

Therefore, it is important to improve these methods of integral assessment to determine the rating of enterprises.

SELECTION OF PREVIOUSLY UNSOLVED PARTS OF THE OVERALL PROBLEM

The basis for the effective economic development of each business entity is the actual implementation of strategies that ensure their sustainable development [7]. Assessment of the ways of development of economic systems is one of the most difficult tasks and, at the same time, a challenge of the XXI Century [8]. Today, the most urgent problems of improving economic indicators are the construction of generalized indicators of socio-economic development of business entities [9].

The research has shown that there is no description of the methodology for calculating the integral indicators necessary for building rating systems and assessing the risk of bankruptcy, developed specifically to solve the problem of

diagnosing the financial condition of business entities based on statistical reporting indicators.

The expediency of using rating systems for financial diagnostics of enterprises is due to the shortcomings of the existing methods for diagnosing the financial crisis at an enterprise. The most significant disadvantages of domestic methods of traditional analysis include: subjectivity of forming a sample of financial diagnostic indicators; insufficient justification and lack of sectoral differentiation of normative values of financial indicators [9]; lack of a multi-level classification of levels of financial stability of an enterprise; presentation of calculation formulas based on outdated reporting forms; failure to take into account qualitative criteria and indicators of production and economic activity; limited range of users (for a certain form of ownership).

PURPOSE

The purpose of the study is to substantiate the theoretical aspects and practical significance of rating assessment, to determine the possibility and feasibility of using the information system of rating assessment for diagnosing the financial condition of enterprises and determining their investment attractiveness and competitiveness, and also to substantiate the need to use the results of rating assessment in developing effective management decisions by business entities.

RESULTS

Freedom of choice in a market economy should be combined with confidence in the reliability of business partners. An effective tool for making quick managerial decisions in this area is the use of rating methods offered by international and national rating agencies, which are actively studied by researchers [4].

A preliminary analysis of the methods and models of rating formation indicates the relevance of their improvement primarily through an integrated assessment of the activities of enterprises. One of the most convenient ways to build a generalized indicator of the investment attractiveness of an economic entity is the Harrington's desirability function [10].

The construction of this generalized function is based on the idea of transforming the natural values of individual indicators into a dimensionless scale of desirability. Harrington's generalized desirability function is the geometric mean of the desirability of individual optimization parameters and has the following form:

$$D = \sqrt[m]{\prod_{i=1}^{m} d_i}, \quad (1)$$

where:
D — is the generalized desirability (the value of the integral indicator of investment attractiveness);
m — number of factor groups;
d_i — partial desirability, $d_i = exp\ (-exp(-G_i))$;
G_i — is a group summarizing indicator of the i-th group in a non-dimensional form:

$$G_i = \sum w_j \tilde{x}_j \quad , \quad (2)$$

where the index j varies within each i-th group.

As a result, a diagram of the model structure was constructed (**Figure 1**), in which the calculation of the weighting coefficients of the input indicators x_j is performed according to the Fishburn rule. Alternatively, they can be determined by experts.

$$w_j = \frac{2(n - N_j + 1)}{n(n+1)}, \quad (3)$$

where:
w_j — is the weighting factor of the j-th indicator;
N_j — is the weight of the j-th indicator, which may vary depending on the investor's goals;
n — total number of indicators.

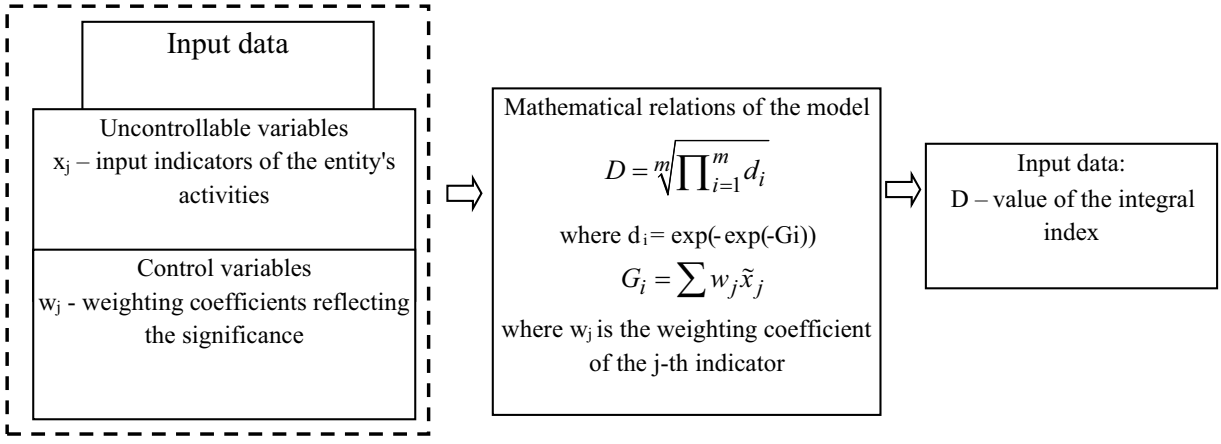

Fig. 1. Schematic description of the model structure

The normalized value of the j-th indicator is calculated by the formula:

$$\tilde{x}_j = \frac{x_j - x_j^{min}}{x_j^{max} - x_j^{min}}, \quad (4)$$

where:
X_jmax and X_jmin — are, respectively, the maximum and minimum values of the jth indicator among all similar input indicators of the studied business entities.

Based on the structure of the model, we developed an algorithm for calculating the enterprise rating, which is shown in **Figure 2**.

The interface of the built model is implemented using MS Excel.

The use of this model makes it possible to obtain the following results: to determine the indicators for assessing the investment attractiveness of business entities to obtain their ratings; to determine the normalized indicators of investment attractiveness, if necessary; to determine the integral indicator of investment attractiveness; to apply the general Harrington desirability function to create a rating for a business entity.

In the following stages of the research, the developed and implemented model was used to: a table with input data on investment attractiveness was created; a calculation table with the investment indicators determined during the modeling for each research object was built; calculation of normalized values of investment attractiveness indicators; to move to the calculation of group summarizing indicators by additive convolution, we calculated the weighting coefficients according to the Fishburn rule; an integral indicator was calculated by using a generalized Harrington desirability function, which allows the numerical quality of an object to be matched with a verbal value of desirability.

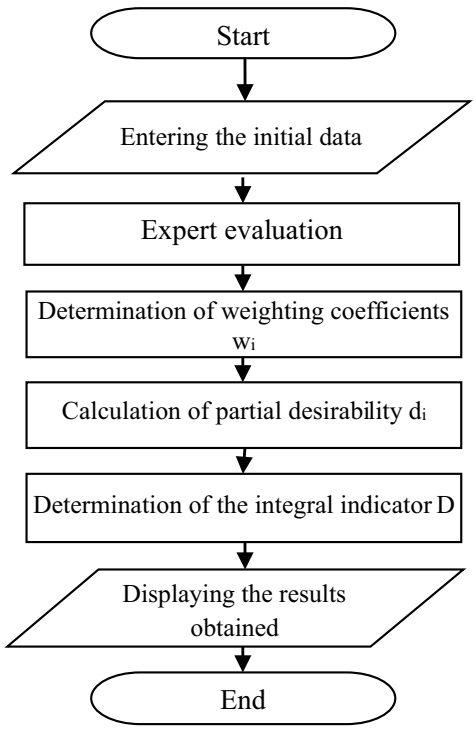

Fig. 2. Algorithm for calculating the enterprise rating

To test the adequacy of the model, an experiment was conducted to confirm the adequate representation of the integrated indicator depending on the input data. If an entity has low investment attractiveness scores, then at the final stage of calculating the level of investment attractiveness using standard marks on the Harrington desirability scale, the interval of values of the desirability function for them should be in the range from 0 to 0,37. Otherwise, enterprises with high scores should be placed in the range from 0,8 to 1.

To test the proposed approach, a model experiment was carried out using Microsoft Excel [11–12].

To calculate the indicators of the enterprise rating, a table with input data was filled in. In the conditions of limited and incomplete information, it is advisable to use expert assessment methods (**Figure 3**).

With the help of an expert assessment, the actual level of each component of the company's work is determined, as well as the importance of each component by ranking (the city is in the list in descending order of importance).

To enter data, we will use so-called smart tables in Excel. Smart tables are dynamic objects that make it easier to organize and analyze large amounts of data. The advantages of using such tables include automatic sorting, filtering, the ability to easily insert new data, and the convenience of using formulas for calculations. Dynamically changing the range of data in the table content automatically expands or shrinks when new rows or columns are added, making the process of updating data more efficient and convenient.

For the convenience of calculations, we will enter additional data for calculations on the Regulatory Reference Information (RRI) sheet. This data includes a table with the values of indicators at the limit marks on the scale of desirability (**Figure 4**).

To perform the calculations, let's first perform linearization. Data linearization is a method of approximating nonlinear data by converting it to a linear form. This approach is used in a large number of fields to simplify analysis and obtain meaningful information from experimental or observational data. The main reasons why it can be useful

Rating assessment system

Number	Name of the component	Maximum level	Actual level
1	Intellectual	5	2
2	Personnel	5	4
3	Technical	5	3
4	Legal	5	4
5	Environmental	5	4
6	Information	5	5
7	Power	5	4
8	Financial	5	5
9	Market	5	3
10	Interface	5	4
	10		**3,8**

Fig. 3. Input data for the rating calculation

Desirability	Ratings on the desirability scale	Values at threshold levels:			
Very good	1,00 – 0,80	very bad - bad	poor - satisfactory	satisfactory - good	good - very good
Okay	0,80 – 0,63	2	3	4	5
Satisfactory	0,63 – 0,37				
Bad	0,37 – 0,20				
Very bad	0,20 – 0,00				

Fig. 4. Values at threshold levels

to linearize data are as follows: linear regression, simplification of data processing, obtaining model parameters, reducing errors, comparative analysis.

All these factors make data linearization a powerful tool for many disciplines.

To do this, we find the constants in the following equation. For the purpose of calculation, we choose the values of the quality indicator that correspond to two values of the desirability function 0,37 and 0,8, which correspond to the borderline values between poor and satisfactory and between good and very good, respectively. Let's find the constants c_1 and c_2:

$$\begin{matrix} 0,37 = exp\left(-exp\left(-c_1\right)\right); \\ 0,8 = exp\left(-exp\left(-c_2\right)\right). \end{matrix} \Rightarrow \begin{matrix} c_1 = -ln\left(-ln\,0,37\right); \\ c_2 = -ln\left(-ln\,0,8\right). \end{matrix} \Rightarrow$$

$$\Rightarrow \begin{matrix} c_1 \approx 0,005764; \\ c_2 \approx 1,50. \end{matrix}$$

Thus, we obtain three systems of equations of the form:

$$\begin{cases} b_0 + 120b_1 = 0,005764; \\ b_0 + 300b_1 = 1,5. \end{cases} \quad \begin{cases} b_0 + 20b_1 = 0,005764; \\ b_0 + 10b_1 = 1,5. \end{cases}$$

$$\begin{cases} b_0 - 18b_1 = 0,005764; \\ b_0 - 25b_1 = 1,5. \end{cases}$$

By solving these systems of equations, we will obtain the values of the coefficients for each of the indicators. Substituting them into the formula $y' = b_0 + b_1 y$, we will find the linearized values of the indicators themselves. Let's summarize these calculations in a separate table (**Figure 5**).

In the next step, we calculate the values of partial desirability and reduce them to a generalized Harrington function using *formula 1* (**Figure 6**).

With the help of macros and the Visual Basic environment, we managed to quickly automate the calculation process [13].

Data for several periods are stored in the Base table. To visualize the change in the company's rating over time, a graph was created (**Figure 7**).

The obtained results serve as an informational basis for managerial decisions on determining the enterprise rating.

When implementing projects, one of the most important aspects is choosing the right software. This process plays a key role in determining the success of the project. Choosing the right software

can ensure efficient and high-quality project implementation, while the wrong choice can lead to poor performance, delays, and project deficiencies.

First of all, it is necessary to clearly define what functions the software must perform, what requirements it must meet, and what needs it must satisfy.

The main aspects that can be used to justify the selection of software: compliance with project objectives and goals, functional capabilities, integration with existing systems, ease of use and training, technical support and updates. cost and budget.

Scoring scale	y'	d_i
1	-1,48841	0,01
2	-0,74132	0,12
3	0,005764	0,37
4	0,752852	0,62
5	1,49994	0,80

Fig. 5. Linearized values of the indicators

Since the goal of our project is to create automated solutions for data processing and reporting, the choice of Visual Basic for Applications (VBA) is a logical decision. VBA is a built-in programming language for Microsoft Office applications such as Excel, Word, Access, etc. The main goal of VBA is to allow users to create macros, applications, and custom solutions directly within these programs, making it much easier to work with data and utomate routine tasks.

Key features of VBA: integration with Microsoft Office; object-oriented paradigm; automation of tasks; user interfaces; data processing; extend functionality; macros and modules; ease of use.

The object-oriented paradigm in the context of VBA refers to an approach to programming where a program is viewed as a collection of objects that interact with each other. Objects are the basic unit of program structure and contain data and functions that are associated with them.

Rating assessment system

Number	Name of the component	Maximum level	Actual level	The importance of the component	Partial desirability d_i
1	Intellectual	5	2	0,18	0,12
2	Personnel	5	4	0,16	0,62
3	Technical	5	3	0,15	0,37
4	Legal	5	4	0,13	0,62
5	Environmental	5	4	0,11	0,62
6	Information	5	5	0,09	0,80
7	Power	5	4	0,07	0,62
8	Financial	5	5	0,05	0,80
9	Market	5	3	0,04	0,37
10	Interface	5	4	0,02	0,62
	10		**3,8**	**1,00**	
				Generalized desirability D_i	0,502

Fig. 6. Results of calculation of the enterprise rating

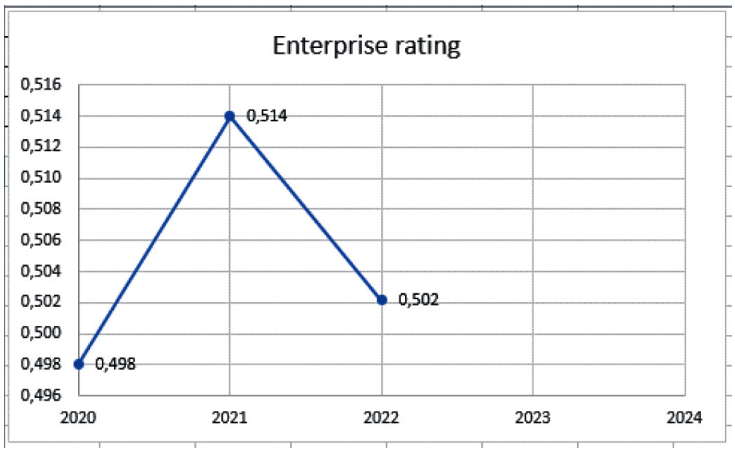

Fig. 7. Graphical representation of the enterprise rating analysis

The object-oriented paradigm allows for a more structured and flexible approach to program development, and provides easy debugging, code reuse, and functionality extensions. In VBA, using the object-oriented paradigm helps you create more organized and efficient applications to automate and extend the capabilities of Office products.

Given the above advantages, choosing VBA to implement our project is a reasonable decision. This will allow us to create an efficient, integrated and functional system that will provide convenient data entry, processing and analysis, as well as ensure high quality and accuracy of the results.

Figure 8 shows the form used to enter the initial data and calculate the rating score of the enterprise. Data entry is performed using a drop-down list, which makes it easy to enter the input data. If the user does not fill in one of the fields, an error message will be displayed.

Experts evaluate the actual level of each component of the company's valuation and determine the weight of each of these components.

The next step is to calculate the integral score. After clicking the "Calculate" button, the result will be displayed in the corresponding field.

The results obtained in this way allow to make a decision on the level of efficiency of certain enterprises, and the developed automated system increases the level of information support in monitoring the overall assessment of the enterprise.

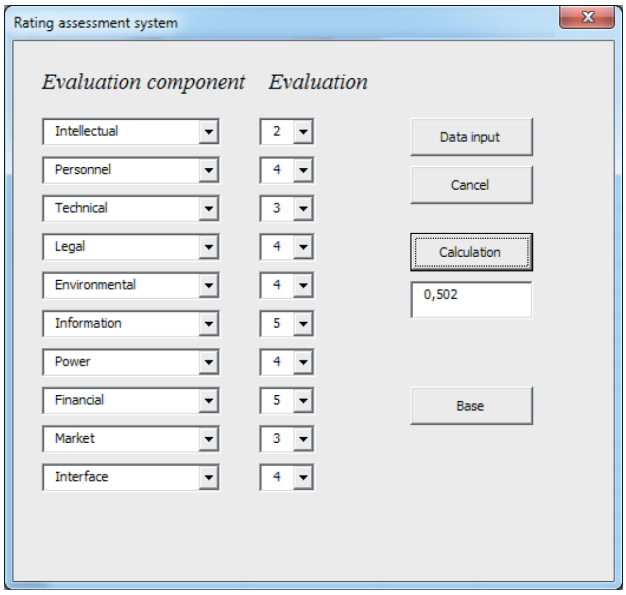

Fig. 8. Input data for calculating the rating of an enterprise

CONCLUSIONS

In today's business environment, in the presence of various risks and uncertainties due to the slow pace of structural reforms, an effective and comparable assessment of the company's performance plays a significant role. In the context of limited resources and fierce competition between enterprises for obtaining them and attracting the maximum possible amount of investment, the issue of creating an investor's perception of the attractiveness of an enterprise, which can be obtained as a result of a rating assessment of its activities, comes to the fore.

The basis for the rating assessment of an enterprise is its financial condition and financial results obtained by the enterprise from the use of its existing assets and attracted sources of financing.

The article studies the methods of rating assessment of an enterprise's activity using various methods. Certain limitations in the use of certain methods have been identified and approaches have been identified that will allow avoiding contradictory conclusions at different stages of the assessment.

As a result of the work, an economic and mathematical model of rating assessment of business entities and its program implementation was developed, which contributes to improving the level of assessment of the efficiency of the enterprise and has a positive effect in making managerial decisions on its development strategy.

In analyzing and studying rating assessment methods and models, it was found that the most successful for application is the model of integral rating assessment. It has a number of advantages, since the assessment of the parameters included in the model, taking into account their significance, significantly increases the probability of obtaining accurate results of the study. Thus, the used method of integral rating assessment of investment attractiveness of an enterprise allows determining, on the basis of the most significant indicators of various areas of activity of an enterprise, selected with due regard for their weight, the degree of proximity of these indicators to the optimal level.

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РОЗРОБКА ІНФОРМАЦІЙНОЇ СИСТЕМИ ІНТЕГРАЛЬНО-РЕЙТИНГОВОЇ ОЦІНКИ ІНВЕСТИЦІЙНОЇ ПРИВАБЛИВОСТІ ПІДПРИЄМСТВА

Резюме. *У статті проаналізовано чисельні методики фінансової діагностики суб'єктів підприємництва, розглянуто методичні підходи до інтегральної оцінки. Здійснено дослідження методів рейтингової оцінки діяльності підприємства за різними методиками. Було виявлено певні обмеження щодо застосування окремих методів і визначено підходи, що дають змогу уникнути суперечливих висновків на різних етапах проведення оцінки.*

Акцентовано на інтегральній оцінці діяльності підприємства. Запропоновано використання функції бажаності Харрінгтона для побудови узагальненого показника інвестиційної привабливості суб'єкта господарювання. Розроблено економіко-математичну модель рейтингового оцінювання, використання якої надає можливість: визначати показники оцінки інвестиційної привабливості суб'єктів господарювання для отримання їх рейтингів; обчислювати нормовані показники інвестиційної привабливості, якщо в цьому є необхідність; розраховувати інтегральний показник інвестиційної привабливості. Для перевірки на адекватність моделі було проведено експеримент, який підтвердив адекватне зображення інтегрованого показника залежно від вхідних даних. Процес рейтингового оцінювання автоматизовано за рахунок створення інформаційної системи, що дозволяє визначати інтегральну оцінку інвестиційної привабливості підприємства з урахуванням його складових. Отримані таким чином результати дають змогу приймати рішення про рівень ефективності діяльності тих чи інших підприємств, а розроблена автоматизована система підвищує рівень інформаційної підтримки під час здійснення моніторингу загальної оцінки діяльності підприємства.

Ключові слова: *рейтинг, інтегральна оцінка, інвестиційна привабливість, фінансова діагностика, інформаційна система, автоматизація.*

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