Роботу присвячено обґрунтуванню теоретичних аспектів та практичного забезпечення оцінки якісного рівня управління розвитком підприємств з урахуванням впливу зовнішнього та внутрішнього середовища.

Уточнено понятійний апарат щодо оцінки якісного розвитку управління підприємствами, який дозволяє обґрунтовано визначати рівень управління за загальновідомими складовими (економічної, соціальної та екологічної), до яких запропоновано додати енергетичну складову. Побудовано новий концептуальний підхід до процедури оцінки якості управління розвитком за рівнями, етапи якої запропоновано розширити за: формуванням бази даних за рівнями управління (державний, регіональний), вибір та оцінка індикаторів за складовими розвитку та сферами діяльності, розробка інструментів щодо покращення управління. Запропоновано інтегральний показника, який відрізняється від існуючих тим, що оцінює якість управління розвитком, а не рівень розвитку. На відміну від запропонованих раніше інтегральний показник враховує вплив зовнішнього середовища за складовими розвитку та внутрішнього – за сферами діяльності по кожній складовій. Тому, має практичну значимість, оскільки стає можливим проводити моніторинг та виявляти негативний вплив управління на розвиток підприємства. На прикладі коксохімічних підприємств визначено склад індикаторів, які характеризують якість управління. Велику кількість індикаторів скорочено за допомогою методу експертних оцінок, що підвищує обґрунтованість вибору. Індикаторні оцінки побудовано виключно за відносними показниками (індексами), що покращує узгодженість. За інтегральним методом проведена оцінка індикаторів за окремими складовими та у цілому. За функцією Харрінгтону побудовано шкалу оцінки якісного рівня управління розвитком підприємств. Новий підхід щодо оцінки якості управління розвитком підприємств та комплекс математичного забезпечення приведе до рівномірного економічного, соціального, екологічного і енергетичного розвитку підприємств

Ключові слова: оцінка рівня управління розвитком, система індикаторних оцінок, складові розвитку, інтегральний показник, шкала оцінки

EVALUATION OF QUALITY LEVEL IN MANAGING THE DEVELOPMENT OF INDUSTRIAL ENTERPRISES

D. Raiko
Doctor of Economic Sciences, Professor*
E-mail: diana.raiko2016@gmail.com

O. Podrez
Postgraduate student**
E-mail: olha.podrez@gmail.com

V. Cherepanova
PhD, Associate Professor**
E-mail: vitcherepanova@gmail.com

I. Fedorenko
Doctor of Economic Sciences, Professor
Department of International Business
And Finance***
E-mail: genasvale1509@gmail.com

Yu. Shypulina
Doctor of Economic Sciences,
Associate Professor*
E-mail: shypulina.j@gmail.com
*Department of Economic Cybernetics and
Marketing Management***
**Department of Management of
Innovative Entrepreneurship and
International Economic Relations***
***National Technical University
«Kharkiv Polytechnic Institute»
Kyrpychova str., 2, Kharkiv, Ukraine, 61002

1. Introduction

The activity of industrial enterprises is mostly influenced by the management system, which is functioning at them. If management does not reach a certain level, the company faces the problem of instability and inefficiency of activity, which indicates the imperfection of the management process.

Every country in the world and business entities aspire to achieve sustainable development in the economy, social sphere, not to worsen the environmental situation and save natural resources. For industrial enterprises of different countries, the issues of energy supply are becoming most important every year, which is caused by the need to purchase energy carriers at high rates. The cost of energy carriers adversely affects the cost of production. That is why the issue of energy supply and energy saving are important for the countries, regions and industrial enterprises. There arises the problem, which needs to be singled out when forming a scientific approach to the evaluation of the quality of the enterprise development management.

Modern theory of development management is implemented based on the estimation of development by compo-

nents and directions of work (spheres of activity). If we imply economic, social and environmental welfare by the development components, the concept of "spheres of activity" was not established at all. Changes in the components of development arise as a result of the influence of factors-indices of external environment (macro- and meso-level), and in spheres of activity – those of internal environment (microlevel). That is, it is advisable to consider the interdependence of the development of an enterprise, industries, regions and the country in general.

There are many procedures for the development evaluation based on the indicators that show the level of stability on the research date and are the absolute indicators. This approach does not show the quality of management development, but only the level of achievement. Thus, the most important practical task is to construct a system of indicator estimates for determining the level of enterprise development management as the effectiveness of management decisions with respect to the previous period.

Thus, the relevance is related to the development of a new approach for evaluating the quality of management of development of industrial enterprises by levels. For this purpose, it is necessary to clarify the theoretical basis of management of enterprise development and the practical content – creation of the estimation procedure, integrated indicator and indicator estimates on the example of coke plants. The evaluation must take into account the specifics of operation by components, spheres of activity and levels of management (macro-, meso- and micro level).

2. Literature review and problem statement

In scientific articles, the problems of assessing the level of management of enterprise development cover the following issues.

The first problem of assessing the level of management of enterprise development concerns the choice of evaluation indicators – analytical or synthetic. In paper [1], analytical indicators are the set of indices and synthetic ones are the set of total indicators that characterize the efficiency of using production resources in relation to the reference production. According to the author's opinion, the synthetic approach is simple and allows comparing the degree of company's activity by sustainability criteria.

This approach is subjective by nature, as the indicators of reference production are not constant and unite only a few areas of enterprise development.

The analytical approach is based on using absolute indicators characterizing the level of achievement. In this case, indicators can be inconsistent with each other by dimension. In addition, there arises the problem if the values of indicators are true, because in scientific articles there are no clear definitions regarding the sources of obtaining information. Thus, the relationships between financial reporting of Spanish enterprises and European corporations are analyzed in paper [2] focusing on reporting on corporative social responsibility. It was proved that the Dow Jones Sustainability Index (DJSI) has a more global nature and cannot be applied to assess the development of enterprises. That is why the authors of paper [2] propose to use the indicators that are constructed according to the data of accounting reports.

Thus, there is a problem regarding the objectivity of using the analytical approach to the assessment of the en-terprise development management. Solution to the problem at the level of enterprises is to use the indicators of financial reporting, analytical and statistical accounts, regional reports of the implementation of the development strategy and annual reports of the industry operation. In addition, it is proposed to use relative indicators that show the growth rate of the index in the present period relative to the previous one and characterize the management quality.

The second issue of assessing the level of management of enterprise development concerns the quality and quantity of the development components. At the same time, this is the problem of not only enterprises, but also of an industry, regions and countries in general.

The qualitative approach to assessing the level of development management relates to studying certain issues, namely: economic growth, population welfare and environmental safety. Thus, in paper [3], the country's development strategies are explored and multiplied linear models of dependences of the economic growth to overcome poverty and income inequality are constructed. The advantage of the approach is simplicity and transparency of modeling. However, this approach does not exclude the existence of a standard error, which is the biggest in the case when poverty and income inequality are zero and constant, and the economic growth is the lowest.

Paper [4] emphasizes the importance of resolving the problems of environmental safety, related to two types of interests – protection of the natural environment and humans from negative consequences. The merit of the study is establishment of the environmental and economic criteria of indicator assessments, as well as the formation of indicators by principles. Assessment of environmental safety is carried out with the help of the system of indicator estimates, which covers a large number of indicators, constituting a set of indicators. The authors assess the effectiveness of environmental measures through the modified indicators of net income, internal return rate and payback period. The use of the mathematical apparatus is not considered in the article.

Thus, the system of indicator estimates, which has a lot of indicators, allows us to estimate the effectiveness of management of enterprise development by components and spheres of activity, take into account the influence of external environment. However, the necessary procedure of gradual formation of indicators, synchronization and evaluation is necessary.

The issues of social responsibility, which are formed according to the regional principle, are considered in research [5]. The authors argue that the regional development is dependent on the level of income and foreign investments. The level of income of the population affects the distribution of social benefits, and foreign investments improve the state of social security. In research [5], the solution of the issue of social responsibility is based on the improvement of corporative management.

Thus, the qualitative approach to assessing the level of development of business entities by separate components helps not only analyze the state, but also proposes management tools for its improvement. However, there arises the problem of comprehensive analysis of the components and the formation of a sequence of actions of estimation and determining the management tools. To solve this problem, the authors of the article propose to design a procedure for evaluating the quality of management of development of industrial enterprises.

The quantitative approach to assessing the level of development management is based on the number of components and indicators. The author of [6] focuses on three constituents of development (economic, social, and environmental) and notes that the set of indicators is peculiar for each country. At the same time, the degree of socio-economic development is of great importance, as it concerns the financial resources, on which the presence of new technologies, resources, skilled personnel and social security of the population depends. And on the other hand, the development of a country is associated with the deterioration of the environmental situation, which is influenced by industrial enterprises. The merit of paper [6] is a historical description of the formation and analysis of the results of implementation of sustainable development, and the weak point is the lack of research into evaluation indicators.

The indicators of development assessment by the economic, social and environmental component for the Lithuanian industry of waste management are developed in paper [7] to assess the tendencies in the industry development. Three levels of sustainable development – low, medium, high – were established. The multidimensional integrated estimation of development stability proved that the economic growth has the greatest influence on the development of Lithuanian enterprises. The article also analyzes the activities of Ukrainian metallurgical enterprises by the economic, social, environmental, risk and market components. It is noted that the risk component shows the influence of the factors of external and internal environment on the development of enterprises of the industry. The market component characterizes the interaction between enterprises and society. The authors proposed the index of sustainable development of a metallurgical enterprise, which is calculated as the mean geometric magnitude of integrated indicators of economic, environmental, social, risk and market stability. The strategic goals, the aim and the place in the strategic groups of the industry are clarified based on the level of development of metallurgical enterprises. However, paper [7] has the shortcomings in establishing the indicators by components. Thus, the economic component includes the extent of the state support for investment projects of the industry, the number of innovative enterprises, and market component includes the existence of the bodies that implement the management of sustainable development. In paper [7], it was established that in assessing the level of management of enterprise development, it is advisable to consider the peculiarities of production, competition and risks. An important conclusion was made regarding the harmonization of economic growth, social progress and environmental responsibility for achieving sustainable development. However, there is a problem of clear consideration of the impact of the indicators by the levels of management (macro-, meso-, micro-) and components of development. It is advisable to redistribute the indicators of the risk and market components, as the risk component relates to production activity, and the market component concerns functioning of the bodies of sustainable development management and the social infrastructure of an enterprise.

In paper [8], only two components for enterprises – economic and social – were separated. But the components cover different directions of work, the essence of which is advisable to determine. The economic component includes industrial, technological, financial, marketing, management, innovation and investment components. The social components include personnel, social welfare and security, organization of labor, motivational, creative and intellectual components. This clarification is positive and shows the feasibility of considering the industrial and entrepreneurial peculiarities, because they will be specific for each industry. At the same time, different spheres of activity are explored in scientific articles.

Thus, in paper [8], the components are specified for the directions of operation that are further defined as "spheres of activity". The disadvantage of article [9] is that only two components of development are analyzed. At the same time, article [9] shows the existence of the problem of determining the spheres of activity for each component of development of an industrial enterprise. Indicators that characterize the sphere of activity should take into account the specifics of operation of enterprises, the state of production funds, financial resources, staff and others.

In article [9], the energy problems of industrial enterprises are separated into a separate component, because operational activity is material and energy-intensive.

The authors of paper [11] insist on the importance of innovations, emphasizing the expediency of technological modernization conducted by industrial enterprises. However, innovative activities are the major factor of development that should be taken into account for each of the components.

Thus, there are difficulties that are related to determining the number of components, levels of management and spheres of activity. The option of overcoming difficulties is the following. Firstly, to consider the state (macro-), regional and industry (meso-) management on the results of activity of enterprises as the influence of the external environment on functioning of each component. Secondly, to use four components – economic, social, environmental and energy – for industrial enterprises, because companies have a high demand for energy carriers. Thirdly, to identify the most important spheres of activity for each component, which will help overcome difficulties in technical preparation of production, cost reduction, increase in demand for products, etc.

Assessment of the level of management by components of development is carried out using various economic and mathematical, statistical, graphic and other methods. The choice of the most effective estimation method is an important task for each enterprise.

In paper [10], the evaluation of technological modernization of production is performed by the method of pairwise correlation using the Kramer system. This approach allows determining the confidence intervals of deviation of the assessment point from the true value, but does not assess the subsequent prospects of development.

In article [11], statistical methods include: aggregation, comparison, different by ways of aggregation (taking or not taking into account the values of separate indicators, statistical methods, expert estimations), by values of indicators (absolute, relative, etc.). The merit of the study is the formation of the stages of quantitative assessment of sustainable development, establishment of indicators in the form of stimulators and destimulators, and standardization of indicators. Development is evaluated by the integrated indicator and the Harrington scale. The disadvantage of this approach is that this paper explores only the issue of regional development, rather than a separate enterprise.

Multi-dimensional regression, least squares method, the dynamic model for assessing the effectiveness of the pension reform, the level of salaries and other social issues

are explored in research [12]. The author considers the solution to the problem under conditions of uncertainty of economic development and uses the multi-factor model of interrelated time series. Modeling the series of dynamics is based on the use of the regression that clearly determined the influencing factors but requires a great amount of statistical information.

The most popular method for assessing the development of a country, regions, industries and enterprises is the integrated method. The authors of [13] determine that many indicators should be used to assess the enterprise development, so the method of standardization of the integrated indicator is proposed. However, two approaches are used in the formation of indicators – quantitative and intuitive, which is of subjective nature. There is a problem of the assessment reliability.

Analysis of literary sources regarding the assessment of the level of management of enterprises' development revealed some unsolved problems that are related to:

– the substantiation and the choice of indicators that characterize the level of management of development of enterprises by components and spheres of activity based on financial, statistical and analytical reporting of enterprises;

– the influence of macro- and meso- management on the components of enterprise development;

– the number of the components of development and spheres of activity;

– the evaluation procedure and the system of indicator estimates of the quality of the management of the enterprise's development by levels.

Today, these problems remain unresolved, as scientific papers consider the assessment of the level of sustainable development of an enterprise, rather than the system of development management.

3. The aim and objectives of the study

The aim of this study is to develop a new approach to the assessment of the level of quality of management of enterprise development based on the assessment procedure, integrated indicator and the system of indicator estimates. This will determine the influence of each component separately, and in general, on the level of management of development of industrial enterprises.

To achieve the aim, the following tasks were set:

– to refine the conceptual apparatus for assessing the level of management of industrial enterprise development and to develop a procedure for assessing the enterprise development management;

– to develop the integrated indicator of assessment of the level of management of the industrial enterprise development by four components, activity spheres and taking into account the influence of the external environment on the components;

– using the example of a coke plant, to determine the indicators that characterize the state of development management by components and areas of activity taking into account the mutual influence on the region, industry and country;

– using an example of a coke plant, to carry out the approbation of the assessment of the level of development management by the integrated indicator and to construct the evaluation scale.

4. Formation of theoretical foundations and practical recommendations for evaluating the level of management of industrial enterprises development

4. 1. Substantiation of conceptual apparatus concerning estimation of the level of management of industrial enterprises development

Modern theoretical basis of the system of management of enterprise development covers the conceptual apparatus concerning "development management", "types of development", "development vector" and others [4].

The issue of assessing the level of management of industrial enterprises development requires clarification of the essence of some terms: process, level, assessment of the level of development management, sphere of activity of enterprises by components, etc.

That is why the main task of management is to control the enterprise development, where by the term "development", it is proposed to imply the directed process of changes in management quality, which ensures the achievement of high performance.

As regards the term "the process of management of enterprise development", it is proposed to consider the actions of the enterprise managers concerning ensuring the sustainable economic, energy and social growth under conditions of the environmental safety of operation of industrial enterprises.

The main task of the process of management of enterprise development is development and implementation of managerial decisions of the top managers regarding the formation of stable and harmonious development of an enterprise according to the economic, social, environmental and energy components.

The concept of "level of enterprise development management" characterizes the quality of management by the evaluation scale.

Assessment of the level of management of enterprise development is the approach to determining the qualitative state of management by every component and as a whole. The approach involves the formation of a procedure, evaluation stages, calculation of the integrated indicator and the evaluation scale.

By the system of indicator estimates of the level of management of enterprise development, we imply a combination of elements (indicators) into a single whole to determine the level of attainability by components, spheres of activity and levels of management (macro-, meso- and microlevel).

The integrated indicator is constructed by the components, spheres of activity, management levels and takes into account specific features of production and the impact of environmental factors.

Assessment of the level of management of enterprise development depends on management levels, which are divided into macro-, meso- and microlevels, i.e. into the factors of external and internal environment. In this case, the factors of the external environment (macro- and meso-level) affect the components of development, and the factors of internal environment influence the spheres of activity.

By spheres of activity, we imply the directions of operation (production, investment, management and others) by separate components and indicators of estimation of the level of management of industrial enterprise development.

Indicators of assessment of the level of management of development of enterprises characterize changes in indica-

tors that took place in the present time in comparison with previous one, that is, they are based on relative indicators.

Thus, the improvement of the conceptual apparatus for estimation of the level of management of development of enterprises, including industrial ones, was proposed.

4. 2. Formation of the system of indicator estimates of the level of management of enterprise development

Analysis of literary sources has shown that there is a system of indicator estimates of the environmental safety of cities [4]. But it is imperfect due to the fact that it covers not all components of the enterprise development and spheres of activity, does not take into account the influence of external environment on the components. If we introduce the economic, social, and energy components to the system, take into account the interrelation between the country, regions, industry and the enterprise, the system will have a structure which is capable of operating when it comes to the quality of development management.

The scientific papers, legislative acts and state strategies [14] identified many principles for the construction of sustainable development in a country, industry. regions, and enterprises. These principles do not concern the formation of the system of indicator estimates.

To form a system of indicator estimates, it is reasonable to use four principles of the construction of a system of indicator estimates – necessity, justification, effectiveness, and systematic consistency. For example, as it is suggested in paper [4], where three principles were established – necessity, justification and effectiveness, but not for enterprises and only for the environmental component of development. Taking into account the practical experience of activity of industrial enterprises, it is possible to propose the use of four principles of the construction of the system of indicator estimates – necessity, justification, effectiveness, and systematic consistency.

For the system of indicator estimates of the level of management of development of industrial enterprises, the essence of the principles is as follows. The principle of necessity shows the importance of conducting the evaluation process. The principle of justification is sufficiency in assessing the state of an enterprise. The principle of effectiveness is conformity with the degree of goal achievement (the highest level of development). Systematic consistency is a sequence of actions to set the structural links between the indicators that characterize the interrelation and interdependence in the development of a country, regions, industry and enterprises.

Based on the proposed principles, a procedure for assessing the level of development management, which consists of ten stages, was developed (Fig. 1). According to the principles of necessity, justification and systemic consistency, the databases are formed and indicators that characterize the mutual impact on the activities of the country, regions, sectors of the economy and enterprises are selected at five first stages. Based on the principles of justification and systematic consistency, the questionnaire is designed, the number of experts is calculated and using the method of expert assessments, the indicators are synchronized at the sixth stage. At the seventh stage, the system of indicator estimates according to the index method is constructed at the seventh stage by the principles of necessity, justification and systematic consistency. Indicators characterize the ratio of the data of the reporting period in relation to the previous period of time. At the eighth stage, based on the principle of justifica-

tion, the integrated indicator of evaluation of development management by components and as a whole is calculated.
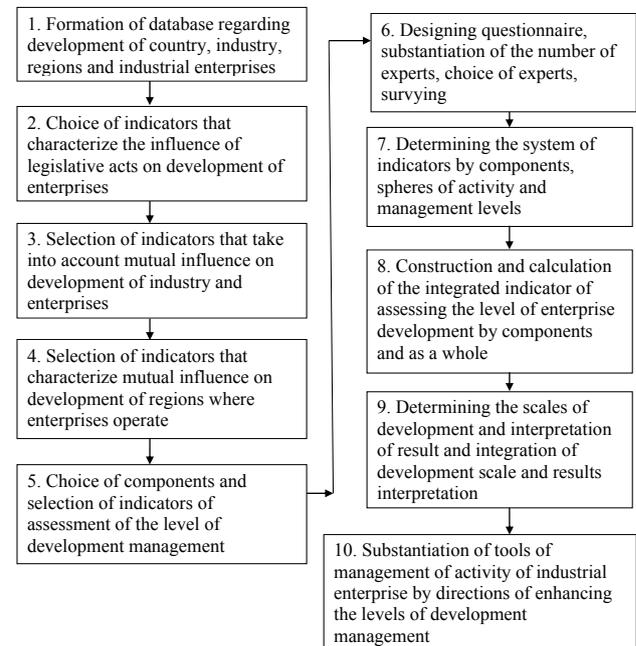
Fig. 1. Procedure for assessing the level of management of industrial enterprises development

At the ninth stage, the scale of estimation of the level of management of enterprise development is substantiated by Harrington function. At the tenth stage, the choice of management tools to improve the level of development of industrial enterprise management is substantiated according to the principle of effectiveness and need.

Formation of the integrated indicator is carried out according to four components of management development (Fig. 2).

Fig. 2. Integrated indicator of estimation of the level of management of development of industrial enterprises for components and spheres of activity

Next, consider the structure of the proposed integrated indicator for the components and spheres of the company's activity (Fig. 2).

The economic component covers the production and technological, investment, organizational and management spheres of activity. The indicators of production and technological sphere of activ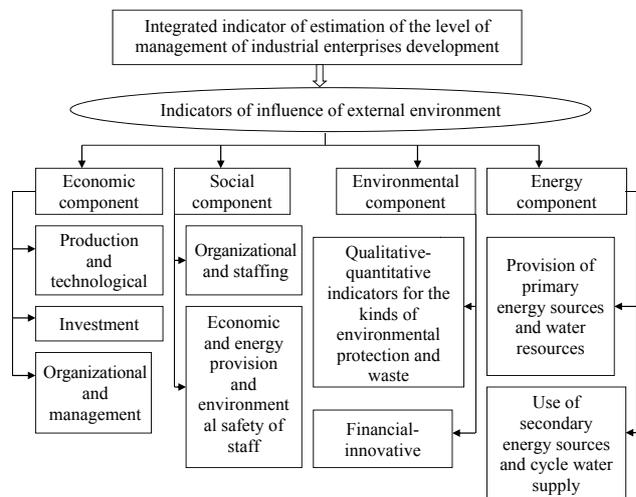ity characterize the state of management of production funds, intangible and tangible assets, technological process etc. The investment component shows the effectiveness of management of financial resources, including the own capital, aimed at improvement of production funds, intangible and tangible assets.

The social component considers the issue of social responsibility of an enterprise to the employees, residents of the region where the enterprise is located. Therefore, it includes the following spheres of activity: organizational and personnel, economic and energy security and environmental protection of the staff.

The environmental component covers the problems of pollution and environmental protection, which is why it is considered at the micro- and meso-level. The spheres of activities of the ecological component are financial-innovative and environmental protection with waste management. Environmental measures require innovative products – funds and technologies, and implementation – financial resources.

The energy component is connected with the solution of the problem of energy and water supply of production and inhabitants of the region, where the company operates, according to primary and secondary sources.

To substantiate the development indicators, the following was taken into account:

1. Influence of the factors of external and internal environment of enterprises on the results of activity.

2. Components of development, used for evaluation.

3. Existence of positive and negative impact on the results of operation of separate factors.

4. The method, by which the indicators are synchronized.

5. The method used to assess the enterprise development.

The approbation of the proposed system of indicator estimates will be based on the example of coke plants (CP).

To take into account the influence of macro- and meso-level regarding the management of industrial enterprises, each of the proposed components includes the analysis of the factors of external environment.

The originality of the proposed approach lies in the fact that, based on four principles (necessity, justification, effectiveness, systematic consistency), the procedure and the integrated indicator of the estimation of the level of management of enterprise development were constructed. This approach differs from the previously proposed one by the fact that it is based on the principles, complex of construction and estimation of effectiveness of enterprise development management. In addition, the integrated indicator has a different form (structure) – indicators of the impact of the external environment by four components (the energy component was added) and by the spheres of activity for each of them. The energy component was constructed by two spheres of activity – provision with primary energy carriers and with the secondary, which contribute to energy saving at an enterprise. In contrast to the existing structures of the integrated indicator, such sphere of activity as economic-energy supply and environmental protection of the personnel was added to the social component. This approach allows solving the problems of social responsibility of enterprises on the problems of energy, economic and environmental protection of the personnel.

In the subsequent study, it is proposed to determine the indicators that characterize the quality of development management by the structure of the integrated indicator on the example of coke plants.

5. Approbation of the proposed system of indicator estimates of the level of development management on the example of coke plants

5. 1. Identification of the problems affecting the development of coke plants and formation of the system of indicator estimation

To determine the indicators by the components of development of coke plants (CP), we will analyze the results of their activity in 2017–2018 (Table 1). Coal is the main raw material used for coke production.

Table 1

Analysis of statistic information by spheres of activity of CP [15]

No.	Indicators	2017	2018	Deviation	
				Absolute	Relative, %
1	Coke production of 6 % moisture content, thousand tons	9,973.1	10,824.2	851.1	8.53
2	Production of metallurgical coke, thousand tons	8,509.9	9,235.4	725.5	8.53
3	Average annual capacity of CP for coke of 6 % moisture content, thousand tons	11,108.0	11,131.1	+23.1	0.2
4	Volume of coal supply from Ukraine, thousand tons	3,170.0	2,560.0	−610.0	−19.24
5	Volume of supply of imported coal	13,790.8	11,911.1	−1,879.7	−13.63
6	Utilization of capital investments, thousand tons	598,518	958,940	360,422.2	+60.22
7	Production of coke gas from the charge thousand m³	231,8503.23	253,3942.77	+215,439.54	+9.29
8	Total exhausts, thousand tons	18.775	19.315	+ 10.54	2.87
9	Coefficient of frequency of total occupational traumatism	0.87	1.88	+1.01	116.09
10	Average recorded number of staff, people	8,938	8,494	−444	−4.97
13	Average monthly salary, UAH	9,055.8	12,477.4	+3,421.6	+37.8

In 2018, coal supply from Ukraine decreased by almost 20 %, and import increased by 13.63 % and is by 4.65 times higher than coal supply from Ukraine.

Average annual capacity of the CP increased in 2018 by 23.1 thousand tons, but according to experts, [15], "the average age of coke batteries as of 01.01.2018 was 28.02. In total, 66.6 % of the operating batteries have the operation term of more than 20 years (normative term), and 7 coke batteries have the operation term of more than 35 years". Despite this, the CP increase the production of both coke with 6 % moisture content, and metallurgical coke.

Capital investments of CP in 2018 increased by more than 60 **%** compared with the previous year, including: investments in new assets – by 199.75 **%**, the cost of overhaul – by 30.79 **%**, the cost of reconstruction, modernization – by 41.28 **%**. The data indicate that the CP is actively engaged in overhaul. All investments were made only with the funds of enterprises.

The production of coke gas from charge in 2018 is 2,533,942.77 thousand m^3, which is by 9.29 **%** more than in 2017. At the same time, 1,971,771.43 thousand m^3 was directed to own needs, 136,343.76 thousand m^3 to third-party consumers and 425,827.58 thousand m^3 were not used.

The CP is actively engaged in environmental protection, but total emissions in 2018 increased by 2.87 % compared with 2017.

Occupational injuries at the enterprises of "Ukrcoke" increased. The average recorded number of personnel decreased by 444 people, and average monthly salary increased by 37.88 % and equals to UAH 12,477.4.

Thus, the conducted study showed that the CP have certain problems concerning the upgrading the production funds, increasing profitability and cost effectiveness, increasing environmental protection measures, reducing occupational injuries, and the use of secondary energy resources.

Taking into account the identified problems, the proposed procedure (Fig. 1) and the structure of integrated index (Fig. 2), a list of indicators for evaluating the level of management of the CP development was presented. The indicators were grouped by the components and spheres of activity in each component in accordance with Fig. 2, so the name of the component and the sphere of activity in Table 2 are not marked with the code.

Table 2

Indicators of assessment of the level of management of the CP development

No.	Indicator	Code
1	2	3
1	Economic component of management of the CP development	–
1. 1	Indicators that characterize the influence of external environment	–
1. 1. 1	Growth rate of production output in metallurgy	P1
1. 1. 2	Growth rate of process for imported coal	P2
1. 1. 3	Growth rate of foreign investment in the activity of the CP	P3
1. 1. 4	Growth rate of volume of coke sales in foreign markets	P4
1. 1. 5	Growth rate of volume of coal purchasing in foreign markets	P5
1. 1. 6	Instability of legislation of Ukraine regarding the entrepreneur activity	P6
1. 2	Indicators the characterize the production and technological activity of the CP	–
1. 2. 1	Growth rate (fall) of volume of coal purchasing in markets of Ukraine	P7
1. 2. 2	Dependence of quality of charge on coal quality	P8
1. 2. 3	Wear and tear of main assets of the CP	P9
1. 2. 4	Upgrading of main assets of the CP	P10
1. 2. 5	Growth rate of coefficient of using production capacity of the CP	P11
1. 2. 6	Growth rate of coefficient of coke quality	P12
1. 3	Indicators that characterize investment activity of enterprise	
1. 3. 1	Growth rate of activity profitability	P13
1. 3. 2	Growth rate of coefficient of covering the balance	P14
1. 3. 3	Growth rate of coefficient of debts	P15
1. 3. 4	Growth rate of coefficient of maneuvering	P16
1. 3. 5	Growth rate of profitability of own capital	P17
1. 3. 6	Growth rate of coefficient of assets turnover	P18
1. 3. 7	Growth rate of investments of the CP	P19
1. 4	Indicators that characterize organizational management activity of enterprise	–
1. 4. 1	Growth rate of labor productivity	P20
1. 4. 2	Growth rate of production profitability	P21
1. 4. 3	Growth rate of costs of staff qualification upgrading	P22
1. 4. 4	Growth rate of coefficient of effectiveness of management activity	P23
1. 4. 5	Growth rate of coefficient of quality of performing the management functions	P24
1. 4. 6	Growth rate of information availability	P25
2	Social component of management of the CP development	–
2. 1	Indicators that characterize the influence of external environment	–
2. 1. 1	Growth rate of minimal salary rate	P26
2. 1. 2	Growth rate of population employment in the country (region)	P27
2. 1. 3	Growth rate of tax load on salary of employees	P28
2. 1. 4	Growth rate of percentage of salary tax	P29

Continuation of Table 2

1	2	3
2. 2	Indicators that characterize the organizational and staff component	
2. 2. 1	Growth rate of female number in personnel structure	P30
2. 2. 2	Growth rate turnover at the enterprise	P31
2. 2. 3	Growth rate the number of occupational injuries	P32
2. 2. 4	Growth rate of the number of employees with higher education	P33
2. 2. 5	Growth rate of average accounted number of employees at an enterprise	P4
2. 3	Indicators that characterize economic-energy provision and environmental protection of the staff	–
2. 3. 1	Growth rate of salary of enterprise employees	P35
2. 3. 2	Growth rate of costs of labor payment in total costs of coke production	P36
2. 3. 3	Growth rate of costs of organizing social events of an enterprise	P37
2. 3. 4	Growth rate of measures for employee's fitness enhancement	P38
2. 3. 5	Growth rate of costs of labor protection	P39
2. 3. 6	Growth rate of thermal energy supply of enterprise employees	P40
2. 3. 7	Growth rate of electric power supply of enterprise employees	P41
2. 3. 8	Growth rate of costs of environmental protection	P42
3	Environmental component of management of the CP development	–
3. 1	Indicators that characterize the influence of external environment	–
3. 1. 1	Growth rate of capital costs of environmental protection of an enterprise to the growth rate of capital costs of environmental protection in the industry	P43
3. 1. 2	Growth rate of current costs of environmental protection to the growth rate of current costs of environmental protection in the industry	P44
3. 2	Quantitative and qualitative indicators for the kinds of environmental protection and waste management	–
3. 2. 1	Growth rate of coke production to growth rate of exhausts of an enterprise	P45
3. 2. 2	Growth rate of waste that has been disposed of	P46
3. 2. 3	Growth rate of waste that was passed to third-party organizations	P47
3. 2. 4	Growth rate of waste disposal in industry to growth rate of waste at an enterprise	P48
3. 2. 5	Growth rate of existence of exhausts of hazardous substances of class 1	P49
3. 2. 6	Growth rate of existence of exhausts of hazardous substances of class 2	P50
3. 2. 7	Growth rate of existence of exhausts of hazardous substances of class 3	P51
3. 2. 8	Growth rate of existence of exhausts of hazardous substances of class 4	P52
3. 3	Indicators that characterize financial-innovative environmental protection activity of the CP	–
3. 3. 1	Growth rate of capital investments in environment protection activity	P53
3. 3. 2	Growth rate of current costs of environment protection activity	P54
3. 3. 3	Growth rate of costs of overhaul of environment protection equipment	P55
3. 3. 4	Growth rate of environment protection measures	P56
3. 3. 5	Growth rate of ecological payments for exhausts ofcontaminants to the atmospheric air	P57
3. 3. 6	Growth rate of environmental payments of dumpingcontaminants to aquatic sites	P58
3. 3. 7	Growth rate of ecological payment of waste	P59
3. 3. 8	Growth rate of enterprise exhausts to growth rate of ecological payment	P60
4	Energy component of management of CP development	–
4. 1	Indicators that characterize the influence of external environment	–
4. 1. 1	Growth rate of consumption of primary power sources in industry in industry, surface water, underground water, etc.	P61
4. 1. 2	Growth rate of tariffs for consumption of primary power sources in industry	P62
4. 1. 3	Growth rate of consumption of water resources in industry	P63
4. 1. 4	Growth rate of costs of consumption of water resources in industry	P64
4. 1. 5	Growth rate of population supply with secondary sources	P65
4. 2	Indicators that characterize supply with primary power sources of and aquatic resources	–
4. 2. 1	Growth rate of power supply with energy carrier	P66
4. 2. 2	Growth rate of using electric power	P67
4. 2. 3	Growth rate of provision with water resources	P68
4. 2. 4	Growth rate of costs of energy supply	P69
4. 2. 5	Growth rate of coke gas production	P70
4. 2. 6	Growth rate of power efficiency of the CP	P71
4. 3	Indicators that characterize the use of secondary power sources and circle water	–
4. 3. 1	Growth rate of using secondary sources of thermal power for own needs of the CP	P72
4. 3. 2	Growth rate of circle water supply by an enterprise	P73
4. 3. 3	Growth rate of realization of coke gas to third-party organizations	P74
4. 3. 4	Growth rate of using coke gas for heating coke batteries	P75
4. 3. 5	Growth rate of using coke gas for boilers	P76
4. 3. 6	Growth rate of using coke gas for other purposes	P77
4. 3. 7	Growth rate of unused coke gas	P78

To substantiate the indicators (Table 2), consider the causal relations. Indicators $P1–P6$ characterize the influence of the external environment on the activity of the CP. Thus, the volume of coke production is directly dependent on metallurgy ($P1$, $P4$), because coke is the main raw material of metallurgical production. Prices for imported coal affect the cost of coke ($P2$, $P5$), since they take more 85 % in the cost structure. Foreign investments contribute to increasing technical preparation of coke production ($P3$), but the CP invests only its own funds. The instability of entrepreneurial legislation increases the risks of its implementation ($P6$).

Indicators $P7–P12$ estimate the management of production and technological activity of the CP. The growth rate, and recently there has been a fall, of the volume of coal purchase of from the Ukrainian mines ($P7$) shows the management of material capacity of coke production. $P8$, $P12$ are the opportunities to improve the coke quality from coal. $P9$, $P10$, $P11$ characterize the state of production funds and the use of production capacity.

Indicators $P13–P19$ assess the quality of management of investment activity of the CP by the liquidity of assets, financial stability, profitability and turnover of assets. $P13$ characterize the management of assets liquidity, $P14$, $P15$ – management of financial stability, $P16$, $P17$ – profitability management, $P18$ – management of turnover of assets, and $P19$ – of implementation of investment results.

Indicators that characterize the organizational-management activity of the CP are $P20–P25$. The production organization is assessed by $P20$, $P21$, $P25$. Quality of managerial activity is determined by indicators $P22–P24$.

$P26–P29$ are the indicators that characterize the influence of external environment on the social component. These include: establishment of the state level of minimum salary ($P26$) and percentage of salary taxes ($P28$, $P29$), as well as the regional influence ($P27$).

Indicators that characterize the organizational-staffing sphere of the CP activity are $P30–P34$, which take into account the changes in the average recorded number of enterprise employees ($P34$), level of education ($P33$), gender issue ($P30$), personnel turnover ($P31$), the number of occupational injuries ($P32$).

The article proposes a new structure of indicators regarding the assessment of the level of management of social protection of the CP staff – $P35–P42$, of material provision – $P35$, $P36$, of social services – $P37$, $P38$, of labor protection – $P39$, of power supply of workers – $P40$, $P41$, of environmental safety – $P42$.

Indicators $P43$, $P44$ show the environmental impact on the ecological component of the management of the CP development as a ratio of the growth rate of capital and current investments of an enterprise and the industry. This approach is typical of coke chemical industry, which is a monopoly.

$P45–P52$ are the indicators that characterize the management of qualitative and quantitative indicators by types of environmental activity. $P45$ shows the dependence of emissions on coke production, $P46$, $P47$, $P48$ are the actions of the CP on waste disposal and transfer to third-party organizations. $P49–P52$ are the amount of harmful exhausts by classes.

Environmental safety of enterprises requires innovative products, repairs of existing equipment and financial investments. That is why indicators $P53–P60$ characterize investment, current costs, repair costs of environmental equipment ($P53–P55$). The growth of the need for envi-ronmental measures ($P56$), an increase in environmental payments ($P57–P58$), an increase in payments for waste placement ($P59$), dependence of environmental payments on exhausts of the CP ($P60$).

The influence of external environment on the ecological component of management of the CP development is carried out according to indicators $P61–P65$. They characterize the conditions established by the state and industry regarding the consumption of primary and secondary energy sources, water resources for the CP and the population of the regions.

Indicators $P66–P71$ assess the level of provision, use, cost and energy efficiency of primary energy carriers and water resources, and indicators $P72–P78$ – of secondary ones.

Thus, the proposed structure of indicators differs from the existing ones by the fact that it takes into account the specifics of coke plants. Indicators of external environment of the economic component assess the impact of the development of coke chemistry and metallurgy, and prices for coal. The indicator of dependence of the charge quality on the coal quality and growth rate of coefficient of coke quality were added to the indicators, which demonstrate the production and technological activity of CP. The growth rate of capital investment of CP was added to the indicators characterizing the investment activity of an enterprise. The group of indicators characterizing economic-energy supply and environmental protection of staff was fully formed by the authors of this paper. However, the new indicators in this group are the growth rate of provision of the company's employees with heat and electric power, as well as the growth rate of the cost of environmental protection. The growth rate of capital and current expenditures of an enterprise on conservation measures to the growth rate of the industry were included to the indicators that characterize the impact of the external environment on the environmental component. This correlation shows the achievement in solving environmental measures by an enterprise in relation to the industry in general. The rate of growth of coke production relative to the growth rate of exhausts of coke plants, the growth rate of the waste that was disposed of and transferred to third-party organizations were added to the indicators characterizing the quantitatively-qualitative indicators of the environmental component. This approach shows the activity of an enterprise regarding waste disposal and efficiency of using. The rate of growth of consumption of primary sources of energy, tariffs, costs and provision of population with secondary sources were added to indicators that characterize the environmental impact on the energy component. The indicators characterizing the provision with primary energy sources and water resources of directly of coke plants are the growth rate of coke gas and energy efficiency of the CP. The indicators characterizing the use of the secondary energy sources are related to the activity of the CP on energy saving: replacing natural gas with coke gas, using coke gas for own purposes and its selling, and reversible water supply.

All these indicators are the innovative approach to the formation of indicators for assessing the level of quality of management of development of coke plants.

In total, there are 78 indicators, by which the impact of the economic, social, ecological and energy components on the level of management of the CP development is assessed. The choice of the most important indicators was conducted by the method of expert estimates. To do this, the sample volume, the number of experts (8 experts), the weight coefficient were calculated and the questionnaire

was compiled. To reduce (synchronize) the indicators, the experts-specialists – heads of enterprises of PJSC "Avdiivka coke plant" (town of Avdiivka, Ukraine), PJSC "Zaporizh-coke" (city of Zaporizhzhia, Ukraine), PJSC "Yuzhcoke" (town of Kamenskoe, Ukraine), PJSC "Kharkiv coke plant" (city of Kharkiv, Ukraine) were invited. The importance of the indicators was measured by the score of 1 to 10 points, the fragment of calculation is shown in Table 3.

Based on the questionnaires of experts as for the components, we obtained the results (Table 4).

Table 3

Fragment of calculation of estimation of the indicators of external environment of the economic component of development management

No	Expert	Indicators					
		1	2	3	4	5	6
1	1	9	10	6	7	4	8
2	2	10	9	7	6	5	9
3	3	9	10	8	7	5	10
4	4	10	9	7	6	6	9
5	5	9	9	8	7	4	9
6	6	10	9	7	6	5	9
7	7	9	10	8	7	6	7
8	8	9	9	6	7	5	8
Total		75	75	57	53	40	69
Number of experts		8	8	8	8	8	8
Mean value		9.375	9.375	7.125	6.625	5	8.625
Specific weight		0.2	0.3	0.15	0.15	0.1	0.1
Value of indicator		1.875	2.8125	1.0688	0.9938	0.5000	0.8625

Notes: 1 – growth rate of production volumes in metallurgy; 2 – growth rate of prices for imported coal; 3 – growth rate of foreign investment in the CP activity; 4 – growth rate of coke sales volumes in foreign markets; 5 – growth rate of coal purchase volume in foreign markets; 6 – instability of Ukrainian legislation on entrepreneurial activity

Table 4

Results of ranking indicators by the economic component

No	Indicator	Value
1. Indicators that characterize the impact of external environmental		
1	Growth rate of imported coal	2.8125
2	Growth rate production output in metallurgy	1.8750
3	Growth rate of foreign investments in the CP activity	1.0688
4	Growth rate of volume of coke sale in foreign markets	0.9938
5	Instability of the legislation of Ukraine on entrepreneurial activity	0.8625
6	Growth rate volume of coal purchase in foreign markets	0.5000
2. Indicators characterizing the production and technological activity of the CP		
7	Wear and tear of main assets of the CP	2.8125
8	Coefficients of coke quality	1.95
9	Dependence of charge quality on coal quality	1.21875
10	Upgrading the main assets of the CP	0.91875
11	Coefficients of using the production capacity of the CP	0.9
12	Growth (fall) rate of the volumes of coal purchase in the markets of Ukraine	0.8375
3. Indicators characterizing the investment activity of the enterprise		
13	Growth rate of capital investment of the CP	2.775
14	Growth rate of coefficient of balance keeping	1.9
15	Growth rate of profitability of own capital	1.125
16	Growth rate of coefficient of debts	1.0125
17	Growth rate of coefficient of assets turnover	0.6375
18	Growth rate of coefficient of maneuvering	0.425
19	Growth rate of activity profitability	0.375
4. Indicators that characterize organizational and managerial activities		
20	Growth rate pf labor productivity	1.975
21	Growth rate of costs of personnel qualification upgrading	1.95
22	Growth rate of coefficient of effectiveness of management activity	1.275
23	Growth rate of the coefficient of quality of performance of management functions	1.1625
24	Level of production organization	0.8625
25	Growth rate of information availability	0.8125

The consistency of experts' opinions on the weight of all indicators was determined by the concordance coefficients, which by the economic component are equal to 0.9, that is, consistency is almost full. Similarly, the indicators were selected for the social, environmental and energy components.

5. 2. Integrated indicator of estimation of management of development of coke and chemical enterprises: construction and calculation

Based on the synchronization of indicators, the approach for the construction and calculation of the integrated indicator of evaluation of management of the CP development was calculated (Table 5).

With the help of the questionnaire, experts selected the indicators (Table 3, 4), which are the basis for the construction of the integrated indicator of the quality of management of the CP development by levels (Table 5). Influence of the economic, social, environmental and energy components on the total integrated index of the estimate of the level of management of the CP development is carried out as the mean geometric magnitude. The novelty of the proposed approach is that the total integrated index shows the level of stability and harmony of the management of enterprise development. In addition to the general index, the integrated indexes for each component, spheres of activity and environmental influence are calculated (Fig. 2). In this case, the indices by the components are the mean geometric magnitude of aggregate indices. Based on the method of Laspares indexed indicator in the numerator shows the data for the reporting period, and the denominator for the basis period. That is why the indicators that characterize the achievement of one or another level of development management by an enterprise are relative indicators, since each indicator is calculated as the growth rate in relation to the previous period. In this way, the indicator shows the quality of management development, since if an indicator is lower than unity, the quality of management is decreased compared to the previous period. This approach makes it possible to avoid the inconsistency of separate indicators by the measure of assessment (tones, meters, hryvnias, number, etc.) and is based on specific results of the enterprise operation. The information provision regarding the calculation of indicators is financial, statistical reporting of an enterprise, an industry, a region, where the company operates, as well as the data of the state statistics service of the country.

Table 5

Integrated indicator of assessment of level of management of development of coke plants (CP)

Total integrated index of estimation of level of management of the CP development $I_d = \sqrt[4]{I_{ec} \times I_{sc} \times I_{enc} \times I_{egc}}$		
1. Integrated index of estimation of the economic component of management of the CP development $I_{ec} = \sqrt{I_{een} \times I_{pt} \times I_{ia} \times I_{om}}$		
1	2	3
Aggregate index of estimation of impact of external environment (I_{een}): $I_{een} = \sqrt{Gr_{pm} \times Gr_p}$	$Gr_{pm} = V_n / V_{n-1}$, $Gr_p = P_{in}/P_{in-1}$	Gr_{pm} is the growth rate of production output in metallurgy; V_n, V_{n-1} are the production output in metallurgy in n and in $n-1$ year; Gr_p is the growth rate of prices for imported coal; P_{in}, P_{in-1} are the prices for imported coal in n and in $n-1$ year
2. Aggregate index that characterizes production and technological activity of the CP (I_{pt}): $I_{pt} = \sqrt{Gr_w \times Gr_c}$	$Gr_w = W_n / W_{n-1}$, $Gr_{cq} = Cq_n/Cq_{n-1}$	Gr_w is the growth rate of wear of main assets; W_n, W_{n-1} are the wear of main production funds in n and in $n-1$ year; Gr_c is the growth rate of coefficient of coke quality; Cq_n, Cq_{n-1} are the coefficient of coke quality in n and in $n-1$ year
3. Aggregate index that characterizes investment activity of the CP (I_{ia}): $I_{ia} = \sqrt{Gr_{ci} \times Gr_{cc}}$	$Gr_{ci} = V_{cin} / V_{cin-1}$, $Gr_{cc} = C_{cn}/C_{cn-1}$	G_{rci} is the growth rate of capital investments; V_{cin}, V_{cin-1} are the volume of capital investment in n and in $n-1$ year; Gr_{cc} is the growth rate of coverage coefficient; C_{cn}, C_{cn-1} is the coverage coefficient in n and in $n-1$ year
4. Index that characterizes organizational and management activity $I_{om} = Gr_{lp}$	$Gr_{lp} = lp_n / lp_{n-1}$	Gr_{lp} is the growth rate of labor productivity; lp_n, pl_{n-1} are the labor productivity in n and in $n-1$ year
2. Integrated index of estimate of social component of management of the CP development $I_{sc} = \sqrt[3]{I_{ee} \times I_{os} \times I_{eeg}}$		
1. Aggregate index of estimate of influence of external environment (I_{ee}): $I_{ee} = \sqrt{Gr_{ms} \times Gr_{tl}}$	$Gr_{ms} = ms_n / ms_{n-1}$, $Gr_{tl} = tl_n/tl_{n-1}$	Gr_{ms} is the growth rate of minimum salary; ms_n, ms_{n-1} are the minimum salary in n and in $n-1$ year; G_{rtl} is the growth rate of tax load; tl_n, tl_{n-1} are the percentage of salary tax load in n and in $n-1$ year
2. Aggregate index that characterizes organizational and stuff component (I_{os}): $I_{os} = \sqrt{Gr_a \times Gr_{oi}}$	$Gr_a = A_n / A_{n-1}$, $Gr_{oi} = O_n/O_{n-1}$	Gr_a is the growth rate of the number of average accounted number of employees of an enterprise; A_n, A_{n-1} are the average accounted number in n and in $n-1$ year; G_{roi} is the growth rate of occupational injuries at an enterprise; O_n, O_{n-1} are the number of accidents, respectively in n and in $n-1$ year

Continuation of Table 5

1	2	3
3. Aggregate index that characterizes the economic and energy provision and environmental security of the stuff (I_{ep}): $I_{ep} = \sqrt{Gr_{as} \times Gr_{cp}}$	$Gr_{as} = AS_n \big/ AS_{n-1}$, $Gr_{cp} = CP_n / CP_{n-1}$	Gr_{as} is the growth rate of average salary at an enterprise; AS_n, AS_{n-1} are the average salary at the enterprise in n and in $n-1$ year; Gr_{cp} is the growth rate of costs of environmental protection; CP_n, CP_{n-1} are the costs of environmental protection in n and in $n-1$ year
3.Integrated index of estimate of environmental component of management of CP development $I_{iec} = \sqrt[3]{I_{iec} \times I_{qq} \times I_{fe}}$		
1. Index that characterizes the influence of environment on the environmental component ($I_{iec} = Gr_{ci}$)	$Gr_{ci} = CI_n / CI_{n-1}$	Gr_{ci} is the growth rate of capital investments in environmental protection of the CP; CI_n, CI_{n-1} are the capital investments in environmental protection respectively in n and in $n-1$ year
2. Aggregate index that characterizes the influence of qualitative-quantitative indicators on the environmental component (I_{qq}): $I_{qq} = \sqrt{Gr_{pe} \times Gr_g}$	$Gr_{pe} = Gr_{cp} \big/ Gr_{de}$, $Gr_q = V_{edn} / V_{edn-1}$	Gr_{pe} is the growth rate of coke production to the growth rate of exhausts of an enterprise; Gr_{cp} is the growth rate of coke production; Gr_{de} is the growth rate of exhausts; Gr_q is the growth rate of disposed exhausts; V_{edn}, V_{edn-1} are the volume of exhausts that were disposed of in n and in $n-1$ year
3. Aggregate index that characterizes financial and investment environmental protection activity of an enterprise (I_{fp}): $I_{fp} = \sqrt{Gr_{cp} \times Gr_{ep}}$	$Gr_{cp} = CC_n \big/ CC_{n-1}$, $Gr_{ep} = Ep_n / Ep_{n-1}$	Gr_{cp} is the growth rate of current costs of environmental protection activity; CC_n, CC_{n-1} are the current costs of environmental protection activity in n and in $n-1$ year; Gr_{ep} is the growth rate of environmental payments; Ep_n, Ep_{n-1} are the environmental payments in n and in $n-1$ year
Integrated index of estimate of energy component of management of the CP development $I_{ieg} = \sqrt[3]{I_{ieg} \times I_{pg} \times I_{sp}}$		
1. Index that characterizes the influence of environment on the energy component of the CP development ($I_{ieg} = Gr_{pgi}$)	$Gr_{pgi} = Pgi_n / Pgi_{n-1}$	Gr_{pgi} is the growth rate of consumption of primary energy sources in industry; Pgi_n, Pgi_{n-1} are the volume of primary energy sources in industry in n and in $n-1$ year
2. Aggregate index that characterizes provision of the CP with primary energy sources and water resources (I_{pq}): $I_{pq} = \sqrt{Gr_{eg} \times Gr_{cg}}$	$Gr_{eg} = Ege_n / Ege_{n-1}$, $Gr_{cd} = Cg_n / Cg_{n-1}$	Gr_{eg} is the growth rate of electricity consumption; Ege_n, Ege_{n-1} are the consumption of electric power in n and in $n-1$ year; Gr_{cd} is the growth rate of coke gas production; Cg_n, Cg_{n-1} are the volume of coke gas production in n and in $n-1$ year
3. Aggregate index that indicates the use of secondary energy sources and reverse water supply (I_{sp}): $I_{sp} = \sqrt{Gr_{sp} \times Gr_{rw}}$	$Gr_{sp} = Sp_n \big/ Sp_{n-1}$, $Gr_{rw} = Rw_n / Rw_{n-1}$	Gr_{sp} is the growth rate of the use of secondary energy sources; Sp_n, Sp_{n-1} are the volume of using secondary energy resources in n and in $n-1$ year; Gr_{rw} is the growth rate of using reverse water consumption; Rw_n, Rw_{n-1} are the volumes of water supply in n and in $n-1$ year

Thus, based on the identified problems in the activity of coke plants and using the method of expert assessments, a new approach to the formation of the integrated indicator of assessment of quality of management of development of coke plants was constructed. The integrated indicator is calculated according to four components that take into account the influence of the external environment and spheres of activity for each component by means of aggregate indices. Aggregate indices are the relative indicators that characterize changes in the quality of management of the enterprise development.

Approbation of the proposed methodological approach to the calculation of the integrated indicator of assessment of the management of development was carried out for the CP – PJSC "Avdiivka coke plant", PJSC "Zaporizhzhia coke plant", PJSC "Yuzhcoke", PJSC "Kharkiv coke plant". The indicators were calculated for the period from 2014 to 2018, the indicators for 2013 were taken as the basis of calculation. The results of calculations of the integrated indicator are shown in Tables 6–9.

According to Table 6, it is evident that PJSC "Avdiivka coke plant" (PJSC ACP) makes a gradual improvement of development management, which leads to enhancement of operation efficiency. In 2014, the integrated indicator was 0.8210, in 2017 – 1.1827, and in 2018 there was a slight decrease – 1.1489. The enterprise has the lowest values by the energy component – 0.4544 in 2014.

Table 6

Results of calculation of integrated indicator of PJSC "Avdiivka coke plant"

Year	Component				Value without root	Value with root
	1	2	3	4		
2014	0.8557	0.9391	1.2250	0.4616	0.4544	0.8210
2015	1.2984	1.4641	0.4645	1.0543	0.9309	0.9822
2016	1.1124	0.8435	0.7899	1.2289	0.9109	0.9769
2017	1.3764	1.3650	0.8713	1.1951	1.9563	1.1827
2018	1.1362	1.1824	1.1810	1.0983	1.7426	1.1489

The development of PJSC "Yuzhcoke" (Table 7) is carried out not evenly, but it reaches the highest level – 1.1349 in 2018.

Table 7

Results of calculation of the integrated indicator of
PJSC "Yuzhcoke"

Year	Component				Value without root	Value with root
	1	2	3	4		
2014	1.1996	0.9918	1.0641	0.9830	1.2445	1.0562
2015	1.0447	0.9322	0.1802	1.0854	0.1905	0.6607
2016	1.0050	0.9656	0.8651	1.0029	0.8420	0.9579
2017	1.1288	1.2147	0.4998	1.0395	0.7124	0.9187
2018	1.1022	1.3794	1.0705	1.0192	1.6589	1.1349

The enterprise has the highest values for the social component – 1.3794 in 2018, and the lowest values – for the environmental component – 0.4998 in 2017.

According to the calculation data (Table 8), PJSC "Zaporizhcoke" carries out its activity inconsistently.

Table 8

Results of calculation of the integrated indicator of
PJSC "Zaporizhcoke"

Year	Component				Value without root	Value with root
	1	2	3	4		
2014	1.1905	0.8518	1.1783	0.8338	0.9963	0.9991
2015	1.1912	1.1441	0.6046	0.9971	0.8215	0.9520
2016	1.2120	1.1236	0.6342	1.0514	0.9080	0.9761
2017	1.3061	1.0956	2.3396	1.0362	3.4691	1.3648
2018	1.1335	1.3769	1.1870	1.0238	1.8966	1.1735

Thus, in 2014, there was a decline to 0.9520, in 2015–2017, there was an increase to 1.3648, and in 2018, the fall to 1.1735. The highest value of the integrated indicator is by the environmental component is 2.3396 in 2017, and lowest is by the environmental component 0.6046 in 2015.

According to the results of calculation of the integrated indicator (Table 9), PJSC "Kharkiv coke plant" has the lowest rates in 2014 and 2018.

Table 9

Results of calculation of the integrated indicator of the estimate of the level of management of development of PJSC "Kharkiv coke plant"

Year	Component				Value without root	Value with root
	1	2	3	4		
2014	0.9556	1.0322	0.8583	0.9399	0.8040	0.9469
2015	1.8006	1.0505	1.1005	1.1670	2.4293	1.2484
2016	1.0318	1.0898	1.0470	1.0820	1.2739	1.0624
2017	0.9395	1.2893	0.9404	1.0173	1.1588	1.0375
2018	0.7549	1.0620	0.7940	0.9506	0.6052	0.8820

The highest level of development management was reached in 2015 – 1.2484, and then there was a gradual fall to the mark of 0.8820 in 2018. The company has the highest integrated indicator for the economic component of 1.806 in 2015 and the lowest by it – 0.7549 was in 2018.

Generalizations of the integrated indicator are shown in Table 10 and Fig 3.

The data in Fig. 3 indicate that the coke plants of Ukraine are developing differently. The largest enterprise is

PJSC "Avdiivka coke plant", which has a stable tendency to increasing the level of development. PJSC "Zaporizhcoke" is not a stable enterprise, but it exceeded the level of management of development of PJSC "Avdiivka coke plant" by 0.0246 in 2018.

Table 10

Value of integrated indicator for plants by years

Name of enterprise	Value of integrated indicator by years				
	2014	2015	2016	2017	2018
PJSC "Avdiivka coke plant"	0.8210	0.9822	0.9769	1.1827	1.1489
PJSC "Zaporizhcoke"	0.9991	0.9520	0.9761	1.3648	1.1735
PJSC "Yuzhcoke"	1.0562	0.6607	0.9579	0.9187	1.1349
PJSC "Kharkiv coke plant"	0.9469	1.2484	1.0624	1.0375	0.8820
Total	3.8232	3.8434	3.9734	4.5037	4.3394
Mean value	0.9558	0.9608	0.9933	1.1259	1.0848

PJSC "Yuzhcoke" also develops by jumps, but in 2018 it almost reached the level of management of development of PJSC "Avdiivka coke plant", the difference is 0.014. PJSC "Kharkiv coke plant has had a tendency to decreasing the quality of management development since 2015, because this enterprise has the worst condition by the economic component.
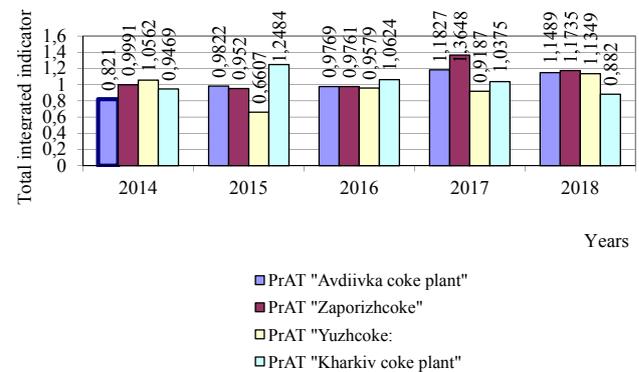

Fig. 3. Dynamics of estimate of the level of management of development of coke and chemical enterprises for 2014–2018

Thus, Fig. 3 shows the total level of management of the CP development for five years, which was calculated from formulas, shown in Table 5. PJSC "Zaporizhcoke" has the highest level of management of development in 2017, and PJSC "Yuzhcoke" has the highest in 2015. In 2018, the level of management of development for PJSC "Avdiivka", PJSC "Zaporizhcoke" and PJSC "Yuzhcoke" is almost identical – more than unity. Only PJSC "Kharkiv coke plant" has the level of management of 0.882.

5. 3. Substantiation of the scale of estimation of the level of management of development of coke plants

In paper [11], it is proposed to construct the estimation scale based on the Harrington desirability function, which takes the following form [16]:

$$d = d(z_i) = \exp(-\exp(-z_i)), \qquad (1)$$

$$z_i = \frac{x_i - x_b^H}{x_b^B - x_b^H}, \qquad (2)$$

where z_i is the code value of indicator; x_i – of value of indicator of output array; x_b^H and x_b^B are the lower and the higher boundary of "satisfactory" in the existing scale.

In paper [16], the lower boundary of the interval "satisfactory" equals to the value of mean arithmetic magnitude, and the upper boundary – to the total value of the arithmetic magnitude and the magnitude of root mean square deviation. Then, according to the rule of "three sigma", approximately 1/6 part of the values of the integrated indicator fall into the interval values of the function "satisfactory", 1/2 – "bad", 1/3 – "good".

If the lower boundary on the Harrington scale is 0.2, the function (1) will be written down as follows:

$$\exp(-\exp(-z)) = 0,2. \tag{3}$$

Then qualitative assessment of the integrated indicator of management of the CP development is calculated according to the data of four enterprises (Table 9).

Table 11

Qualitative assessment of the integrated indicator of the level of development management

Name of enterprise	Qualitative estimate of the index of the level of development management			
	LB Bad	LB Satisfactory	HB Satisfactory	HB good
PJSC "Avdiivka"	0.9601	1.0224	1.1535	1.2190
PJSC "Zaporizhcoke"	1.0187	1.0931	1.2497	1.3281
PJSC "Yuzhcoke"	0.8691	0.9457	1.1070	1.1877
PJSC "Kharkiv coke plant"	0.9763	1.0355	1.1599	1.2222
Total	3.8242	4.0966	4.6701	4.9569
Mean value	0.9560	1.0242	1.1675	1.2392
Acceptable value	0.96	1.02	1.17	1.24

The generalized function of desirability of the level of management of the CP development is the result of synthesizing private functions of desirability of four coke plants, which form the basis of its estimation scale (Table 12).

Table 12

Scale of estimation of the level of management of the CP development

Qualitative evaluation of the index of level of management of the CP development	Intervals of values of quantitative evaluation of appropriateness index
Very good	>1.24
Good	[1.17; 1.24]
Satisfactory	[1.02; 1.17]
Bad	[0.96; 1.02]
Very bad	<0.96

According to the scale of estimation of the level of development management in 2018, PJSC "Avdiivka CP" has satisfactory state, PJSC "Zaporizhcoke" – good state, PJSC "Yuzhcoke" – satisfactory, PJSC "Kharkiv coke plant" – very bad. Thus, the scale of evaluation of development management characterizes the level of management of enterprises, but has little discrepancy in the estimation levels – 0.28.

6. Discussion of results of development and approbation of the proposed system of indicator estimates of the levels of management of enterprise development

In determining the level of management of development of coke plants that follows from the obtained results (Tables 6–9), the influence of separate indicators by the components of development – economic, social, environmental and energy – is natural. This is due to the fact that coke chemical enterprises must develop consistently, rather than solve only the issues of increasing profitability. The problems of social welfare of workers, environment protection and energy efficiency of production (the use of coke gas and reverse water supply) need solving. It should be noted that PJSC "Avdiivka coke plant" implements its management over all determined components and areas of management, which is why there is a gradual increase and almost the highest level of management.

Obviously, this approach allows monitoring the management of enterprise development according to the reporting data by the components and spheres of activity. A simple mathematical apparatus, based on the methods of mathematical statistics, contributes to timely correction of managerial decisions to increase the level of existing development. In this sense, the interpretation of the results of assessment of the level of management of enterprise development, shown in Fig. 3, is of particular interest, which proves the ambiguity and inconsistency of the CP activity. This indicates the need to construct the tools of management of development of industrial enterprises – capitalization of incomes and expenses, occupational health and environment, and increasing social responsibility of an enterprise.

However, unlike the results published in paper [13], the obtained data on the assessment of the level of management of development of coke chemical enterprises enable asserting the following. The system of indicator estimates of the CP includes indicators for the development components (economic, social, environmental and energy) and spheres of activity. In addition, it considers the influence of the environment by the levels of management (macro- and meso-level). The proposed approach to functioning of the system is based on the use of expert estimates, integrated method and Harrington desirability function.

Such conclusions can be considered appropriate from the practical point of view, because they allow a reasonable approach to determining the level of management of development and identify the problems in the management of enterprises. The improvement of management requires the necessary tools, by means of which the CP can achieve the highest level of development – sustainable development.

The evaluation scale (Table 12) has a small threshold of values, which imposes certain limitations on the use of the obtained results and can be interpreted as the drawbacks of this study. The impossibility to withdraw the mentions restrictions within this study generates a potentially inter-

esting direction for further research. In particular, they may be focused on setting intermediate scales of evaluation for each of the components of development management – environmental, energy, social and economic. This detection will allow investigating the management of the CP development by separate components, which significantly affect the beginning of the "negative' development.

7. Conclusions

1. The essence of the concept "management of enterprise development" was refined. It differs from the concept of "enterprise development" by the fact that it characterizes the level of the quality of management development, rather than the level of development as a whole. The clarification allowed determining the concept of "the process of management of the enterprise development", which is based on four components – economic, social, environmental and energy. The factors of the environment and spheres of activity were found to influence the components. The spheres of activity characterize the directions of operation on improvement of the development management by the corresponding components. The level of development management is determined using the system of indicator estimates.

The principles of formation of the system of indicator estimates (necessity, justification, effectiveness, systematic sustainability) were established, through which the procedures for assessing the level of management of enterprise development were constructed. The procedure differs from the previously proposed ones by the fact that it covers the entire complex of evaluation:

– includes the stages of the formation of the database by management levels (macro-, meso-, micro-), by the components and spheres of activity of an enterprise;

– takes into account the specifics of entity operation and modern state of actives, passives, etc.;

– evaluates the quality of management of the enterprise development by each component as a whole, which allows reasonable formation of the tools of development management.

2. We constructed the integrated indicator of estimation of the level of management of enterprise development, which differs from the existing ones by components and spheres of activity and takes into account the influence of the factors of external environment on components. In this case, we specified the components of the management of development of industrial enterprises – the energy component was added to the well-known ones (economic, social and environmental). It was proposed to consider each component by the spheres of activity. The economic component covers the production and technological, investment and organizational-manage-

ment spheres of activity. Apart from the organizational-personnel sphere of activity, the economic and energy provision and environmental protection of the staff was added to the social component. Quantitative and qualitative indicators of the environmental component characterize the company's actions by the types of environmental protection and waste management, as well as the financial and innovative activities. The energy component of enterprise development, which shows the enterprise's provision with primary energy sources and water resources and the use of secondary energy sources and reverse water supply, was separated. Macro- and meso- levels of management influence all the components, which is manifested through the appropriate indicators of the environment.

3. The system of indicator estimates was considered on the example of coke enterprises. The indicators take into account the specifics of the production activity, social responsibility, occupational safety, environmental protection activity and energy saving of coke plants. That is why the indicators are presented according to the components and spheres of activity for each of them, as well as by the levels of management. Indicators are relative, since they are the rate of growth of the corresponding indicator in relation to the previous period. The indicators show the changes in the quality of the management of enterprise development. The novelty lies in the comprehensive solution of the problem of establishing the indices by four components and spheres of activity that take into account the influence of the environment (macro- and meso-level) on each component.

4. Approbation of the developed approach was carried out on the example of coke and plants. Based on the obtained results and the new approach to calculating the integrated indicator, the calculations for four coke plants for the period of 2015–2018 were carried out. The conclusion was made that enterprises develop unevenly. PJSC "Avdiivka coke plant", which has a stable endency to increasing the level of management of the enterprise development, pays most attention in terms of the management of the economic, social, environmental and energy development. PJSC "Zaporizhcoke" is not a stable enterprise, but in 2018 it exceeded the level of development management of the PJSC "Avdiivka coke plant".

According to the scale of assessment of the level of development management, in 2018, only PJSC "Zaporizhcoke" has a good management state, PJSC "Avdiivka CP" and PJSC "Yuzhcoke" – satisfactory, PJSC "Kharkiv coke plant" – very bad. Thus, the scale of assessment of management development characterizes the quality of management of enterprises, but has a slight discrepancy by the evaluation levels.

References

1. Posłuszny, K. (2017). Methods of the industrial enterprises sustainable business assessment. Prace Naukowe Uniwersytetu Ekonomicznego we Wrocławiu, 491, 332–339. Available at: https://www.ceeol.com/search/article-detail?id=615943

2. López, M. V., Garcia, A., Rodriguez, L. (2007). Sustainable Development and Corporate Performance: A Study Based on the Dow Jones Sustainability Index. Journal of Business Ethics, 75 (3), 285–300. doi: https://doi.org/10.1007/s10551-006-9253-8

3. Islam, R., Bashawir Abdul Ghani, A., Zainal Abidin, I., Malar Rayaiappan, J. (2017). Impact on poverty and income inequality in Malaysia's economic growth. Problems and Perspectives in Management, 15 (1), 55–62. doi: https://doi.org/10.21511/ppm.15(1).2017.05

4. Grachev, V. A., Plyamina, O. V., Lobkovsky, V. A. (2016). Indicator Evaluation of Environmental Efficiency Measures to Ensure Environmental Safety. Voprosy sovremennoj nauki i praktiki. Universitet imeni V.I. Vernadskogo, 3, 21–30: doi: https://doi.org/10.17277/voprosy.2016.03.pp.021-030

5. Valentiny, T., Gonos, J., Timková, V., Košíková, M. (2017). Impact of selected factors on the formation of regional disparities in Slovakia. Journal of Applied Economic Sciences, 12 (6 (52)), 1626–1639. Available at: https://www.researchgate.net/publication/322094853

6. Klarin, T. (2018). The Concept of Sustainable Development: From its Beginning to the Contemporary Issues. Zagreb International Review of Economics and Business, 21 (1), 67–94. doi: https://doi.org/10.2478/zireb-2018-0005

7. Filipishyna, L., Bessonova, S., Venckeviciute, G. (2018). Integral assessment of developmental stability: cases of Lithuania and Ukraine. Entrepreneurship and Sustainability Issues, 6 (1), 87–99. doi: https://doi.org/10.9770/jesi.2018.6.1(7)

8. Posilkina, O. V., Bratishko, Yu. S., Svetlichnaya, K. S. (2015). Diagnostics of sustainable social and economic development of pharmaceutical enterprises. Upravlinnia, ekonomika ta zabezpechennia yakosti v farmatsiyi, 3, 44–50.

9. Raiko, D. V., Podrez, O. I. (2018). The Formation of Instruments of Management of Industrial Enterprises According to the Theoretical and Functional Approaches. Business Inform, 3, 386–393.

10. Kenesheva, G., Alimbayev, A. (2018). Technological modernization of industry. Journal of Applied Economic Sciences, 13 (8), 2416–2426.

11. Savkiv, U. S. (2012). Integral Estimates of Sustainable Development of the Region. Business Inform, 1, 45–50.

12. Mukasheva, G., Zhakisheva, K., Yernazarova, A., Tazhikenova, S., Zhumanova, D., Kurmanova, G. (2018). Economic problems of the development of agro-industrial complex: Mechanism of solution. Journal of Applied Economic Sciences, 13 (7), P. 2017–2030.

13. Sokil, O., Zhuk, V., Vasa, L. (2018). Integral assessment of the sustainable development of agriculture in Ukraine. Economic Annals-XXI, 170 (3-4), 15–21. doi: https://doi.org/10.21003/ea.v170-03

14. Stratehiya staloho rozvytku Ukrainy do 2030 roku: PROEKT-2017 (2017). Kyiv, 110.

15. Itogi raboty koksohimicheskih predpriyatiy i proizvodstv Ukrainy v 2018 godu (2019). Dnipro, 73.

16. Kamyshnikova, E. V. (2009). Methods of complex estimation formation for enterprise economic security level. Ekonomika ta upravlinnia pidpryiemstvamy, 88–92. Available at: http://www.stattionline.org.ua/index.php/ekonom/34/2326-metody-formirovaniya-kompleksnoj-ocenki-urovnya-ekonomicheskoj-bezopasn