The competitiveness, market value and income of an enterprise depend on the level of intellectual property management. Therefore, the aim of research is to develop, substantiate and test a scientific and methodological approach to a quantitative and qualitative assessment of the management of intellectual property of industrial enterprises.

The originality of the proposed approach is that on the basis of the concept of "management of intellectual property" a procedure for current management has been developed, the main stage of which is a quantitative and qualitative assessment. The assessment is based on the structural and logical model, which is built according to two criteria. The criteria make it possible to determine the current state of the use of intellectual property (intangible assets) – a quantitative assessment, and the prospect of further use (intellectual potential) – a qualitative assessment.

A quantitative assessment involves the calculation of indicators characterizing the state of assets, the dynamics of the impact on the market value of the enterprise, the profitability of production, which is proposed to be determined through the net cash flow from operating activities. A qualitative assessment is carried out in terms of components (information and investment, organizational and legal, economic, personnel and motivation), tools and relative indicators that characterize the intellectual potential of an industrial enterprise. The assessment is carried out using a general integral indicator, which is of practical importance, since it shows the existing level of intellectual property management and directions for improvement in the future.

The approbation of the scientific and methodological approach was carried out on the example of three Ukrainian coke-chemical enterprises (CJSC Avdeevka Coke Plant, CJSC Zaporozhkoks, CJSC Yuzhkoks) of the American association SUNCOKE ENERGY, INC and the Polish association J.S.W. S.A. Group. Empirical studies for the period from 2015 to 2019 made it possible to build a scale for assessing the level of intellectual property management according to the Harrington function

Keywords: intellectual property, intangible assets, intellectual potential, quantitative and qualitative assessment of management

UDC 658.1: 330.111.62
DOI: 10.15587/1729-4061.2021.230262

DEVELOPMENT OF SCIENTIFIC AND METHODOLOGICAL APPROACH TO QUANTITATIVE AND QUALITATIVE ASSESSMENT OF INTELLECTUAL PROPERTY MANAGEMENT IN INDUSTRIAL ENTERPRISES

Diana Raiko
Doctor of Economic Sciences, Professor
Department of Economic Cybernetics and Marketing Management**
E-mail: diana.raiko2016@gmail.com
Viktoriia Cherepanova
PhD, Professor*
E-mail: vitcherepanova@gmail.com
Ihor Sylka
Postgraduate Student*
E-mail: Ihor.Slk94@gmail.com
Olha Podrez
Doctor of Philosophy in Economics, Leading Engineer
Department of Public Administration and Entrepreneurship
National Aerospace University "Kharkiv Aviation Institute"
Chkalova str., 17, Kharkiv, Ukraine, 61070
E-mail: olha.podrez@gmail.com
Irina Fedorenko
Doctor of Economic Sciences, Professor
Department of Economics and Marketing**
E-mail: genasvale1509@gmail.com
*Department of Innovative Entrepreneurship Management and International Economic Relations**
**National Technical University «Kharkiv Polytechnic Institute»
Kyrpychova str., 2, Kharkiv, Ukraine, 61002

Received date 16.03.2021
Accepted date 19.04.2021
Published date 30.04.2021

How to Cite: *Raiko, D., Cherepanova, V., Sylka, I., Podrez, O., Fedorenko, I. (2021). Development of scientific and methodological approach to quantitative and qualitative assessment of intellectual property management in industrial enterprises. Eastern-European Journal of Enterprise Technologies, 2 (13 (110)), 28–41. doi: https://doi.org/10.15587/1729-4061.2021.230262*

1. Introduction

With the transition of the world to the information age or post-industrial society, intellectual property (IP) is increasingly important in the competitiveness of industrial enterprises. IP characterizes the results of economic, innovation and legal processes related to the mental activity of personnel, and is aimed at increasing the profitability of enterprises. IP objects of industrial enterprises function as objects of economic activity and law. The objects of economic activity include inventions, utility models, industrial designs, rationalization proposals, trademarks, brand and commercial names, topography of integrated circuits, trade secrets, computer programs, databases, know-how, neural networks, cloud computing, geographical indications. To the objects of law – property, related rights, permits and the like.

Copyright © 2021, Authors. This is an open access article under the Creative Commons CC BY license

Thanks to the use of intellectual property, industrial enterprises produce science-intensive products that carry out innovative activities and introduce inventions, utility models, software products, know-how and others.

The study of the experience of foreign countries in the management of intellectual property indicates that the role of intellectual property in modern production is constantly growing, therefore, considerable attention is paid to management issues.

IP management is actions aimed at ensuring effective planning, organization and control of the processes of formation, motivation, development and use of IP objects. In the financial statements of industrial enterprises, IP objects are indicated as intangible assets.

Business entities have different schemes for the acquisition, creation and use of intellectual property, affects the final financial result from the application.

But in order to get a positive result from the use of intellectual property objects, it is necessary to constantly assess the level of management efficiency.

Therefore, it is urgent to develop a scientific and methodological approach to assessing the effectiveness of the levels of management.

2. Literature review and problem statement

The work [1] presents the results of a literary review of scientific publications on intellectual property (IP) management and found that publications cover several areas. So, in works [2, 3] the importance of IP management is analyzed, but questions about the mechanism and tools of IP management remain unresolved.

Many publications [4–6] simplify the process of IP management to patenting and insist that the efficiency of IP management depends on timely patenting. The reason for this is the objective difficulties associated with the registration of patents for IP objects. But patenting is only one of the controls and requires a separate stage as part of IP management.

The work [7] presents the results of technical, information resources of patenting, which is advisable to refer to intellectual property. A new classification of patent offices is presented. It is noted that the current state of IP rights is insufficiently developed in terms of technical support. The use of blockchain can't fully meet the need for established IP rights on a broader scale. Therefore, the IP management process should take into account the construction of a database of information resources of patenting at industrial enterprises.

The work [8] discusses the issues of licensing of IP objects from the point of view of the role of licensing agreements on the internal innovation process and IP management strategies. However, there are still issues of assessing the effectiveness of strategic IP management.

The authors of [9] investigate the mechanisms for protecting intellectual property, since "there is a tension between the goal of sharing knowledge with external partners and the need to protect valuable know-how." But the work [9] did not raise the question of the impact of IP protection mechanisms on the effectiveness of management.

The paper [10] provides an analysis regarding the filing of applications by startups for patents or trademarks from venture capital, which showed that applications and trademarks are used more often. Venture capital SMEs are rapidly acquiring brands and marketing their inventions as IP through start-ups. The work [10] reveals the advantages and disadvantages of establishing rights through trademarks and patents, but does not disclose the process of managing the commercialization of IP objects.

The authors of [11] investigate the relationship between open innovation and the use of patents, industrial designs, trademarks and copyrights in small and medium-sized enterprises using regression. The authors concluded that industrial designs are the most effective rights to protect intellectual property in open innovation cooperatives. However, the work [11] does not consider the issues of rights management as one of the most important stages of IP management.

Works [12, 13] are devoted to the analysis of the creation, appropriation and use of IP objects in small and medium-sized enterprises, including industrial ones. The research is interesting because the peculiarities of IP management in the context of the enterprise strategy are clearly defined.

The authors of [12, 13] showed that the management (strategy) of intellectual property should be integrated and consistent with the general strategy of SMEs and adapt to different stages of business development. IP affects innovative development, self-esteem (market value), competitiveness, image, and increases the income of an industrial enterprise.

The authors note that the process of managing the IP of SMEs includes:

– assessment of the current market situation, technology, company and business environment;

– determination of the desired situation with IP to ensure a competitive position;

– analysis of available options for transition to a more competitive market in terms of IP creation;

– decision on the allocation of resources for the implementation of strategies.

So, the work examines the need and stages of intellectual property management [13]. At the same time, the important fact is emphasized that for industrial SMEs, internal knowledge is dominant and focused on the development of innovative activities, while large corporations are characterized by the acquisition and use of external technologies.

The authors insist on the strategy of knowledge management, including industrial enterprises [4, 14–16]. However, these papers emphasize the importance of using informal security mechanisms such as runtime and trade secrets. This helps to increase the competitiveness of enterprises. The authors note that formal protection mechanisms, in particular, patents, trademarks and geographical indications, negatively affect the competitiveness of an enterprise.

Today, the innovative activity of industrial enterprises is based on the use of the developments of research institutes, since there are no scientific departments at enterprises. In [15], the features of IP management in research programs and projects funded by the state are considered. The projects use mixed methods – quantitative network analysis and qualitative semi-structured interviews. The study was conducted to examine the best practices for creating intellectual property in the framework of the Japanese government research and development program. The results of the network analysis showed that the main/peripheral structure in the patent network contributes to the creation of intellectual property through the joint application of the university and industrial enterprises.

In [17], a knowledge management model based on the use of conversations, verification and control of knowledge, transformation of tacit knowledge, identification of competence, document management and the use of a collaborative network is considered. However, the issues related to the assessment of the effectiveness of using the model, the authors propose to consider in further research through the system of indices.

Thus, the authors of scientific works [1–17] solve the problems of creating IP objects, protection of rights, management mechanisms. But in the works there is no clear structure, components and tools of the IP management mechanism.

The development of industrial enterprises depends on the use of modern technologies, equipment, know-how and other IP objects, and the efficiency of their implementation depends on a high-quality management system.

The authors [18] focus on the methodological approach to assessing the effectiveness of enterprise asset management, consists of six stages:

1. Analysis of the state of asset management.

2. Calculation of the effectiveness of management by the Harrington function.

3. Analysis of the calculated indicators for the effectiveness of asset management.

4. Analysis of the reasons that influenced the calculation of indicators.

5. Formation of recommendations for improving the calculation result.

6. Monitoring compliance with the recommendations [18].

The advantage of this approach is its complexity, which allows to calculate the integral indicator and evaluate it using the Harrington function. At the same time, an in-depth analysis of indicators is used, with the help of which the causes of deficiencies in asset management are determined and recommendations for their improvement are developed.

The disadvantage of [18] is that the authors analyze all assets according to established indicators, although intangible assets have their own assessment indicators.

The author of [19] also focuses on the consideration of the process of assessing the effectiveness of the management of intellectual property of enterprises on the basis of an integral indicator. The integral indicator is based on five factors: profitability of products sold; output per employee; the coefficient of science intensity of production; mechanical vision; current liquidity ratio.

When calculating the integral indicator, the significance of the factors is taken into account.

The disadvantages of the methodological approach include the small number of analyzed coefficients.

The work [20] systematizes the existing approaches to methods and indicators for assessing the efficiency and effectiveness of managing the processes of creating and using IP objects. Methods for assessing IP management include:

– Balanced Scorecard – a tool for strategic management of the enterprise, is a based assessment of its performance, indicators and metrics are used that reflect the key areas of the enterprise;

– Scandia navigator – 30 key indicators. Financial metrics also include customer, process, human, development or recovery direction;

– IP index – combining several different indicators into one index that links intellectual property with changes in the market;

– scoreboard (project) of the value chain – identifying the opportunities of enterprises to innovate;

– report on intellectual capital (Intellectual Capital Accounts) – thanks to its indicators, it is possible to assess the intellectual potential by different methods;

– VAIC – Value Added Intellectual Coefficient is calculated as a coefficient of intellectual added value and consists of variable indicators of capital budgeting, financial planning, goal setting, performance measurement, interaction with shareholders, material incentives, coefficient of intellectual added value. The composition includes 164 indicators;

– Tobin's coefficient q – the market value of the company in relation to the cost of replacing fixed assets;

– a taxonomy based on the calculation of the distance of the indicators of the management assessment of the base enterprise to the ideal. The taxonomy method is subjective, since it is not known by what qualitative indicators the standard itself is assessed and how progressive it is in relation to the basic indicators.

The positive aspect of the work [20] is the systematization of existing methods for assessing IP management, and the disadvantage is that the methods are considered aimed at assessing the management of intellectual capital, which includes working capital.

In another work [21], it is proposed to assess the effectiveness of IP management by components – economic, innovation, personnel, organizational, information. The author has compiled a system of indicators for each component.

The article [22] identifies five components for IP management:

– management of the results of scientific and technical creativity, objects of IP rights;

– management of people creating objects of IP rights;

– management of organizations, order and use objects of IP rights;

– management of the state IP system.

The author [23] defines four components – management of the creation of intellectual products; organizational and methodological base of IP; IP information support and communications; portfolio of IP objects.

So, the components of the management for assessing its effectiveness are considered in the works of Ukrainian scientists, but there is no single approach to the quantity and purpose.

The work [24] highlights certain issues of ownership of IP objects.

Other researchers, in addition to the issue of law on the development and use of IP objects, add the issues of market analysis, purchase, sale, technology transfer, and also determine the importance of forming an IP assessment mechanism.

In addition, in the works [18–24] there is no unified approach regarding the indicators for assessing the quality of IP management. So, the author [25] does not single out the components, but examines the indicators for assessing the enterprise's IP management, in which it includes indicators for the overall assessment of the system and the functioning of individual components of management.

In work [26], absolute and relative indicators are proposed for each component, but they do not characterize changes in IP management. The indicators proposed in [26] are absolute and relative, but do not show how the state of management of IP objects is changing at the present time in comparison with the past.

Thus, IP assessment is carried out by methodological approaches that make up management and assessment indicators.

To form a model for assessing IP management, it is necessary to build a scientific and methodological approach to the formation of effective management, the use of intangible assets as IP objects and the presence of a high level of intellectual potential of the enterprise.

3. The aim and objectives of research

The aim of research is to develop, substantiate and test a scientific and methodological approach to the quantitative and qualitative assessment of the IP management system, which makes it possible to determine measures to improve management, property status and competitiveness of industrial enterprises.

To achieve the aim, the following objectives have been set:

– to define the essence of the concept of "IP management" and build a procedure for current management;

– to analyze the current state of the use of intellectual property objects at industrial enterprises on the example of the by-product coke industry;

– to develop a theoretical basis for a scientific and methodological approach to assessing the quantitative and qualitative level of intellectual property management;

– to test the scientific and methodological approach of quantitative and qualitative assessment of intellectual property management using the example of coke-chemical enterprises.

4. Materials and methods of research

The research was carried out on the basis of the theories of enterprise management, management, financial accounting of assets, international financial reporting standards. All calculations were performed using Microsoft Excel. The experimental part of the study was based on real data of enterprises of the coke industry in Ukraine, Poland and the United States, which are presented in the open press on the websites of enterprises. The model for calculating the general integral indicator of management assessment is adequate, since all data and indicators are comparable to each other. The model was based on an index method based on relative indicators characterizing the efficiency of asset use and indicators of a qualitative impact on intellectual potential. Assessment of intellectual property management was carried out using an integral indicator, inextricably linked intangible assets and intellectual potential.

5. Results of the study to assess the quantitative and qualitative level of intellectual property management of industrial enterprises

5. 1. Theoretical substantiation of the intellectual property management process at industrial enterprises

In [27], conceptual approaches to defining the essence of the concept of "IP management" are analyzed and it is proposed to consider this term as a management process that solves strategic and current tasks in the activities of enterprises.

Strategic IP management is part of the overall strategy of an industrial enterprise, which requires additional research. The current management of the IP allows to determine the features of the process (Fig. 1).

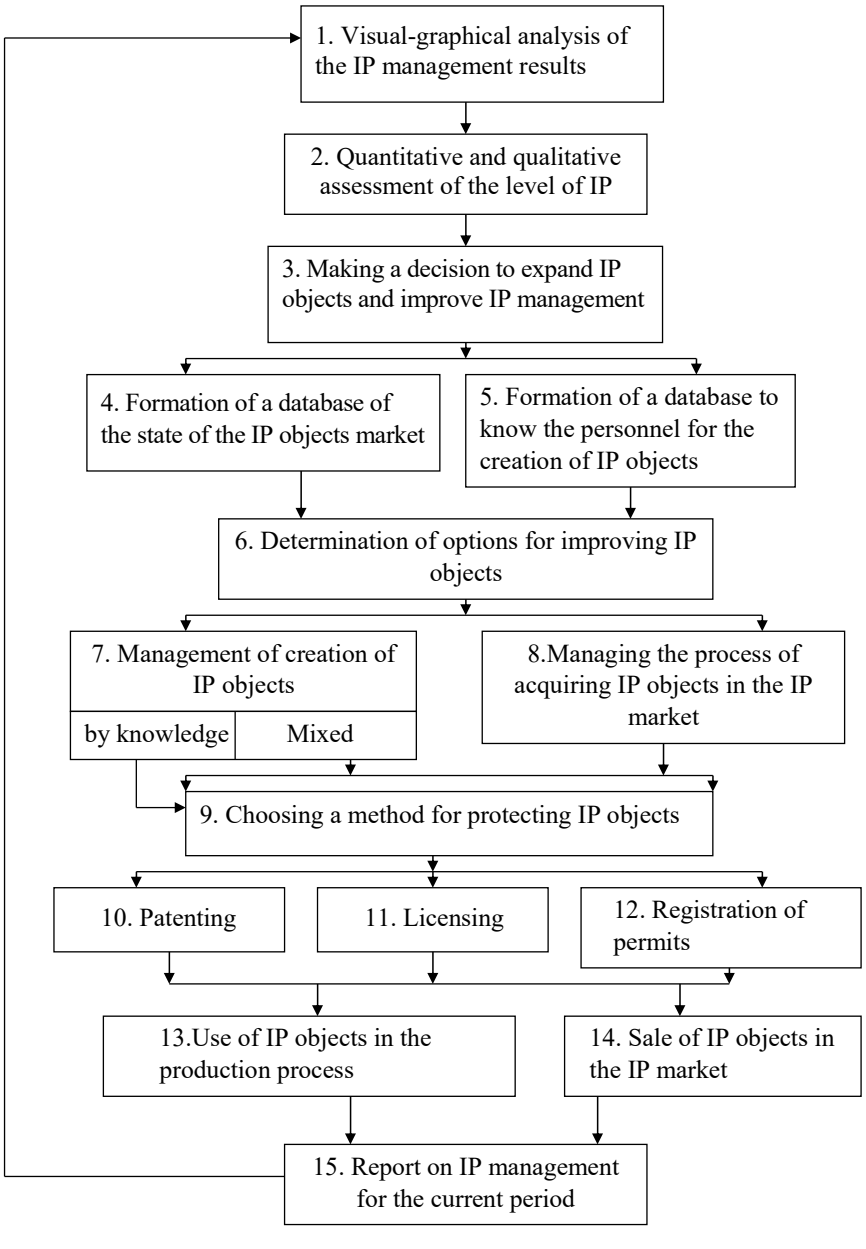

Fig. 1. The process of the current management of intellectual property in industrial enterprises

Fig. 1 shows the procedure for the current management of the IP of an industrial enterprise, which consists of fifteen stages. At the first stage, the visualization of the general analysis of IP management is carried out with the construction of graphic material, which allows to see the positive or negative result of management. Visualization is a comparative analysis of IP management for different enterprises in the same industry. At the second stage, the effectiveness of the use of intangible assets is assessed according to the proposed indicators (quantitative assessment) and intellectual potential (qualitative assessment). At the third stage, a management solution is developed to improve the management of IP over objects, methods of development and acquisition, as well as the method of protecting rights to IP objects. At the fourth and fifth stages, the process of forming a database on the market for IP objects and personnel qualifications is carried out. On the sixth, let's define options for improving the use of IP objects. The seventh and eighth stages focus on the creation and acquisition of intangible assets in the target IP market. At the same time, the creation of IP objects is carried out based on the knowledge of the enterprise personnel and in conjunction with industry research institutes (mixed creation). The ninth, tenth, eleventh and twelfth stages are devoted to the choice of the method of protection of rights, divided into patenting, licensing and registration of permits. At the thirteenth stage, IP objects are sent to production to increase the income and competitiveness of the enterprise and products. Some of the unoccupied intangible assets are sent for sale is the fourteenth stage. At the last (fifteenth stage), a report on IP management is drawn up, and if there are negative or, on the contrary, good results that need to be expanded, the management procedure starts from the first stage.

Thus, to carry out the procedure for the current management of IP, it is advisable to build a scientific and methodological approach with a quantitative and qualitative assessment of the level of IP management. This approach differs from existing ones in that it assesses the current state of IP use and future development prospects.

5. 2. Visual-graphical analysis of intellectual property management by industrial enterprises

Visual and graphical benchmarking is an important step in the ongoing IP management. The analysis contains an assessment of the use of IP objects for the financial statements of the enterprise, which indicates as intangible assets, the impact on the income of the enterprise, the conduct of innovative activities for the participants in scientific and technical research and sources of funding. Visual graphic analysis proves the relevance of the development of a scientific and methodological approach to the quantitative and qualitative assessment of IP management and the directions in which the assessment is carried out.

Since the assets are classified as irreversible, they are depreciated and reported at their original and residual values (Fig. 2).

The study of changes in the initial and residual value of intangible assets of Ukrainian coke oven plants showed that every year more intangible assets are used by *CJSC Avdeevka Coke Plant* (Ukraine) and CJSC Zaporozhkoks (Ukraine). However, Ukrainian enterprises almost never replenish the original cost of intangible assets.

Fig. 3 analyzes the value of intangible assets of coke-chemical enterprises (CCE) in Ukraine, Poland and the USA.

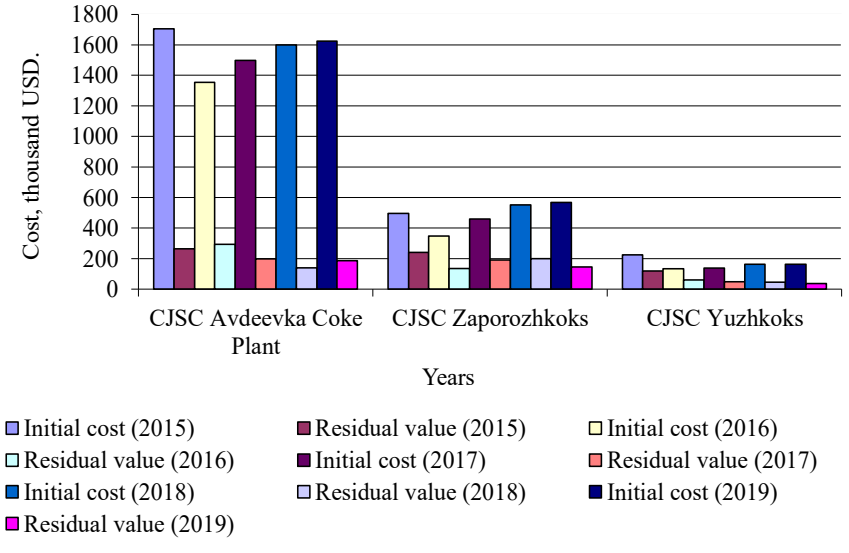

Fig. 2. Dynamics of intangible assets of coke-chemical enterprises (CCE) by initial and residual value for the period from 2015 to 2019 [28–30]

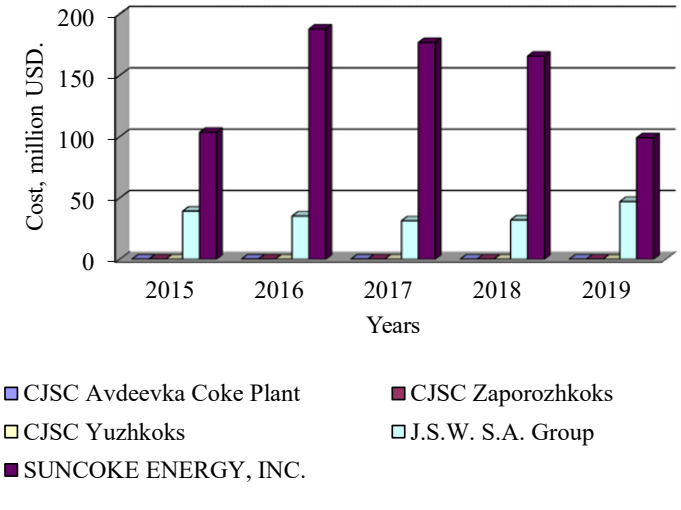

Fig. 3. Dynamics of intangible assets of coke-chemical enterprises of Ukraine, Poland and the United States by residual value for the period from 2015 to 2019 [28–32]

Compared to CCE in Poland and the USA, Ukrainian enterprises hardly use intangible assets, which is a negative fact. Because, thanks to the use of assets, the market value of the enterprise and the competitiveness of the products increase. The IP objects of industrial enterprises in Ukraine include [33]:

– the right to use natural resources and property;

– rights to commercial designations (rights to trademarks (marks for goods and services), commercial (firm) names, etc.);

– rights to industrial property objects (the right to inventions, utility models, industrial designs, layouts (topography) of integrated circuits, trade secrets, including know-how, protection from unfair competition, etc.);

– copyright and related rights (computer programs, programs for electronic computers, data compilation (databases);

– other intangible assets (the right to carry out activities, the use of economic and other privileges, etc.).

Intangible assets are not determined by the costs of research and improving the business reputation of the enterprise (goodwill). Therefore, on the balance sheet of Ukrainian coke-chemical enterprises, intangible assets include software, new processes, other assets (licenses, patents, non-exclusive rights to use computer programs with a service life of no more than a year).

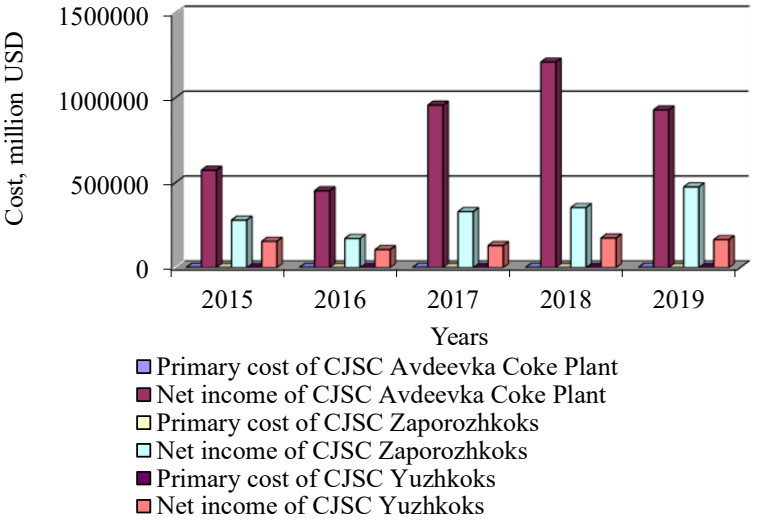

Fig. 4. Dynamics of the impact of intangible assets on the net income of coke-chemical enterprises [28–30]

The composition of the intangible assets of Poland and the United States differs from that of Ukrainian enterprises. Thus, intangible assets of Poland [31], in addition to goodwill, include:

– geological information – the right to use geological information, capitalized by the amount of expenses incurred for its acquisition. The estimated useful life of geological information is from 5 to 45 years;

– software – purchased software licenses are capitalized for the amount of costs incurred to acquire and use specific computer software. Capitalized costs are written off over the estimated useful lives of the software, which is between 2 and 10 years;

– certificate of the origin of energy, which allows an industrial enterprise to independently purchase or sell energy resources. Ownership rights arising from certificates of origin for energy produced from renewable energy sources are created when the certificates are entered in the register and expire at the time of their redemption. Deadline for the obligation to redeem certificates of origin or pay a replacement fee per year.

Unlike coke plants in Poland, US intangible assets [32] include:

– goodwill;

– environmental and operational permits required to operate a coal export terminal in accordance with the US Environmental Protection Agency ("EPA") and other regulatory agencies;

– permission to purchase special water use.

Analysis of the results of the study of the impact of intangible assets on net income in accordance with the coke-chemical enterprises of Ukraine (Fig. 4) and foreign (Fig. 5) showed that the use of these assets has almost no effect on the activities of industrial enterprises. This fact is explained by the fact that there are no assets related to innovative activities of enterprises – "know-how", utility models and inventions in the structure of coke-chemical enterprises (coke-chemical enterprises). Net income of an enterprise is understood as the amount of revenue excluding indirect taxes.

When analyzing the impact of intangible assets on the net income of Ukrainian enterprises, the cost of goodwill was not taken into account (Fig. 4).

The American company has larger volumes of intangible assets than Polish enterprises, but in the period from 2016 to 2018, assets grew (especially in 2016), and income increased at a slow pace until 2019. At Polish enterprises, intangible assets have almost no effect on income growth, but the growth rates are much higher (Fig. 5).

Thus, studies have shown that Ukrainian CCEs use permits, rights as intangible assets, and foreign associations use goodwill, certificates, permits.

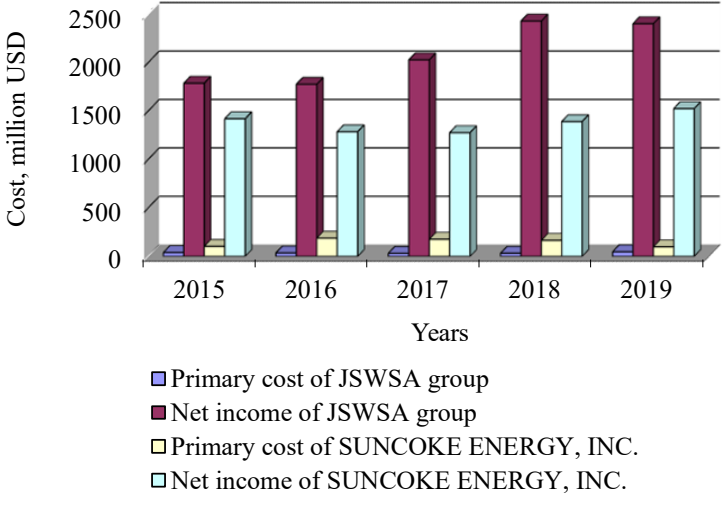

Fig. 5. Dynamics of the impact of intangible assets on the net income of foreign companies [31, 32]

The value of intangible assets of Ukrainian CCEs is decreasing (Fig. 4), and foreign ones – growing (Fig. 5).

The work of coke-chemical enterprises is associated with innovative activities. Among the three coke-chemical enterprises in 2018, CJSC Zaporozhkoks (Ukraine) has the highest expenditures on innovative activities – 421.307 thousand USD, CJSC Avdeevka Coke Plant

(Ukraine) – 326.115 thousand USD, CJSC Yuzhkoks (Ukraine) – 27.615 thousand USD (Fig. 6). However, in relation to the production cost of products, these costs are only: CJSC Zaporozhkoks – 0.107 %, CJSC Avdeevka Coke Plant – 0.024 %; CJSC Yuzhkoks – 0.015 %.

The innovative activity of Ukrainian food processing enterprises is associated with both external research and development, and with internal ones.

Most of the Ukrainian coke-chemical enterprises are part of the Ukrainian Scientific and Industrial Association "Ukrkoks" (USPE "Ukrkoks"), which has two research institutes – the state enterprise "Ukrainian State Coal Chemistry Institute (SE UKHIN)" and the state enterprise "State Institute for the Design of Coke Industry Enterprises (SE GIPROKOKS)". SE "UKHIN" and SE "GIPROKOKS" carry out scientific research and create innovative products for the coke oven industry.

Fig. 7 shows the internal costs by type of research of the state enterprise "Ukrainian State Coal Chemistry Institute (SE UKHIN)" and the state enterprise "State Institute for the Design of Coke Industry Enterprises (SE GIPROKOKS)". After analyzing the statistics of investments in research and development, let's determine that SE "UKHIN" is engaged in applied and scientific and technical developments, and SE "GIPROKOKS" – only in scientific and technical. At the same time, SE "GIPROKOKS" receives approximately nine times more funding. But both of these institutions are not engaged in fundamental research (Fig. 7).

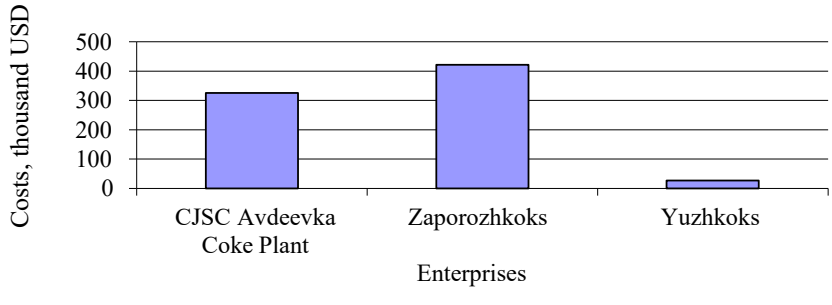

Fig. 6. Analysis of costs for innovative activities of Ukrainian coke-chemical enterprises, thousand USD [28–30]

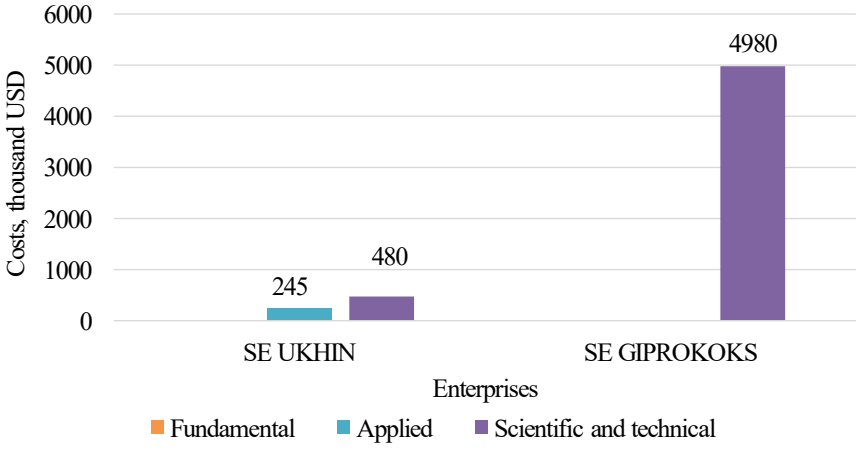

Fig. 7. Cost analysis by type of research of the state enterprise "Ukrainian State Coal Chemistry Institute (SE UKHIN)" and the "State Institute for the Design of Enterprises of the Coke Industry (SE GIPROKOKS)" [34]

Thus, the analysis of the use of IP objects of the by-product coke industry by Ukrainian, Polish and American enterprises showed that at present, business entities do not include objects that are innovative products. This situation in relation to intangible assets does not contribute to an increase in competitiveness, product quality and production profitability.

To improve the efficiency of CCE activities, it is necessary to assess the IP management, the theoretical and methodological approach of which is given below.

5. 3. Theoretical substantiation of the scientific and methodological approach to assessing the quantitative and qualitative level of intellectual property management

The assessment of the management of intellectual property (IP) of an industrial enterprise is understood as a stage based on determining the level of management, and allows management to take timely measures for improvement.

The original essence of the assessment is revealed in the structural-logical model (Fig. 8), built according to two criteria – the level of use of objects that are presented in the financial statements of enterprises as intangible assets, and the level of intellectual potential (capabilities) of the enterprise.

The index method based on the calculation of the integral indicator was chosen as the assessment method. Unlike expert assessments determined by experts and are subjective in nature, it is the most objective, since it involves the use of indicators characterizing the effectiveness of management.

In [35], a methodological approach to assessing the efficiency of using intangible assets is presented, which is taken as a basis, but with changes, taking into account the specifics of the activities of industrial enterprises. This assessment is quantitative as it includes calculation of indicators.

The integral indicator for assessing the management of intangible assets consists of four areas:

– assessment of the state of intangible assets by the degree of amortization, which is calculated as the ratio of the residual and original value and shows how much the assets are used at the time of the analysis;

– definition of intangible assets in the property complex of the enterprise, which characterizes the proportion of intangible assets in the balance sheet currency and in the composition of non-current assets;

– dynamics of intangible assets, which characterizes the growth rate in terms of residual value in the reporting and previous (base) periods, and the growth rate of the balance sheet currency for the same period;

– profitability, which characterizes the efficiency of using intangible assets, which is proposed to be calculated through the indicator of net cash flow from operating activities (cash-flow), and return on assets – the ratio of cash-flow to the average annual residual value of fixed assets and intangible assets.

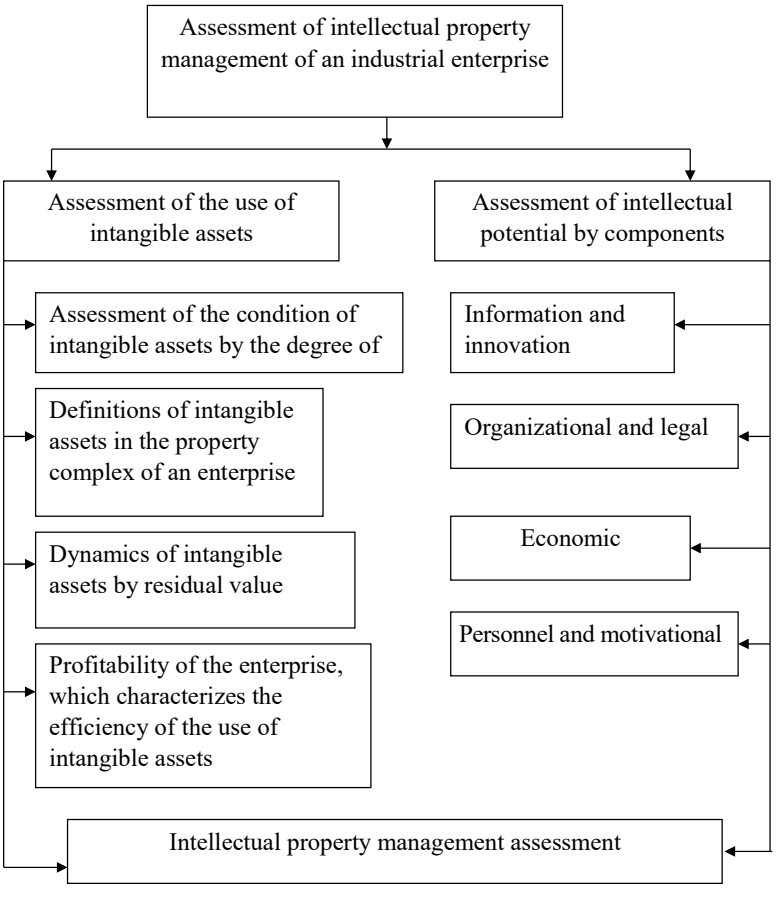

Fig. 8. Structural-logical model for assessing the management of intellectual property of an industrial enterprise

The assessment of the level of the intellectual potential of the enterprise is carried out according to the components of potential development [26], such as: information and innovation, organizational and legal, economic and personnel motivational (Table 1). It is proposed to evaluate the components of the intellectual potential of an enterprise using management tools and indicators.

The assessment is made using relative indicators (growth rates), therefore, as noted by the authors of the article [36], it is qualitative. However, some indicators should not be taken into account when calculating the integral indicator, since they are not currently used in many industrial enterprises. This is due to the low interest of the management in the use of such IP objects as know-how, utility models and inventions. Over time, industrial enterprises will be able to engage in production. Therefore, the most significant indicators for assessing the intellectual potential of the enterprise were selected.

The proposed scientific and methodological approach to quantitative and qualitative assessment of IP management of industrial enterprises is based on the use of formulas (1)–(24).

Integral indicator for assessing IP management (I_{IP}):

$$I_{IP} = \sqrt{I_{ana} * I_{IPA}}, \quad (1)$$

where I_{ana} – integral indicator for assessing the management of intangible assets; I_{IPA} – integral indicator for assessing the intellectual potential of an enterprise.

Integral indicator for assessing the management of intangible assets (I_{ana}):

$$I_{ana} = \sqrt{I_{pia} * I_{sia} * I_{dia} * I_{fia}}, \quad (2)$$

where I_{sia} – assessment of the state of intangible assets by the degree of amortization; I_{pia} – place of intangible assets in the property complex of the enterprise; I_{dia} – index of growth of intangible assets with the growth rate of the balance sheet of the enterprise; I_{fia} – profitability and capital productivity of intangible assets.

Assessment of the state of intangible assets by the degree of amortization (I_{sia}):

$$I_{sia} = K_{via}, \quad (3)$$

where K_{via} – coefficient of validity of intangible assets.

Table 1

Indicators for assessing the qualitative state of the intellectual potential of an industrial enterprise

No.	Components of intellectual potential	Management tools	Management indicators
1	Information and innovation	Informative	– growth rate of the number of submitted IP applications; – growth rate of the number of proposals in a certain area of research
		Innovative	– growth rate of development financing; – index of the innovative potential of the enterprise
2	Organizational and legal	Organizational	– science intensity index; – the rate of increase in the life cycle of IP objects at the enterprise
		Legal	– the rate of increase in the quality of rights to IP objects
3	economic	Financial	– growth rate of investments in R&D; – growth rate of the value of intangible assets
		Marketing	– growth rate of expenditures on IP market research
4	Personnel and motivational	Personnel	the growth rate of workers performers of scientific and technical work; – growth rate of the share of scientific and technical work performers in the total number of personnel; – growth rate of employees with advanced degrees
		Motivational	– the growth rate of material incentives for the creation of IP objects

$$K_{via} = \frac{F_{ria}}{\Phi_{iian}}, \quad (4)$$

where F_{ria} – residual value of intangible assets, thousand USD; F_{iia} – initial cost of intangible assets, thousand USD.

Place of intangible assets in the property complex of the enterprise (I_{pia}):

$$I_{pia} = \sqrt{K_{scia} * K_{iaia}}, \quad (5)$$

where K_{scia} – ratio of the share of intangible assets in the balance sheet currency at their original cost; K_{iaia} – coefficient of the share of intangible assets in non-current assets.

$$K_{scia} = \frac{F_{via}}{C_b}, \quad (6)$$

where C_b – balance currency; F_{nae} – the cost of non-current assets of the enterprise, thousand USD.

$$K_{iaia} = \frac{F_{dia}}{F_{iie}}. \quad (7)$$

The growth index of intangible assets with the growth rate of the balance sheet currency of the enterprise (I_{dia}):

$$I_{dia} = T_{ria} / T_{gbc}, \quad (8)$$

where T_{ria} – growth rate of intangible assets at the end of the year; T_{gbc} – the growth rate of the balance sheet currency at the end of the year.

$$T_{ria} = \frac{F_{riar}}{F_{riab}}, \quad (9)$$

where F_{riar}, F_{riab} – the residual value of intangible assets for the reporting and base periods, thousand dollars.

$$T_{gbc} = \frac{B_{br}}{B_{bb}}. \quad (10)$$

where B_{br}, B_{bb} – balance sheet currency for the reporting period and base.

Profitability and return on assets of intangible assets (I_{fia}):

$$I_{fia} = \sqrt{P_{ra} * CF}, \quad (11)$$

where P_{ra} – return on assets; CF (cash flow) – Net cash flow from operating activities, thousand USD

$$CF = F_p - F_{ia} + A_{aaa} + A_{faa}, \quad (12)$$

where F_p – profit (loss), thousand UAH; F_{ie} – income tax expenses, thousand USD; A_{aaa} – average annual amortization of intangible assets, thousand USD; A_{faa} – average annual depreciation of fixed assets, thousand USD

$$P_{ia} = CF / \left(F_{aaiia} + F_{aara}\right). \quad (13)$$

where F_{aaiia} – average annual initial cost of intangible assets, thousand dollars; F_{aara} – average annual residual value of fixed assets, thousand USD.

Integral indicator for assessing the intellectual potential of an enterprise (I_{IP}):

$$I_{IP} = \sqrt{I_{ifin} * I_{orp} * I_{ec} * I_{pm}}, \quad (14)$$

where I_{ifin} – assessment of the impact of the information and innovation component of the intellectual potential of the enterprise; I_{orp} – assessment of the impact of the organizational and legal component of the intellectual potential of the enterprise; I_{ec} – assessment of the impact of the economic component of the intellectual potential of the enterprise; I_{pm} – assessment of the impact of the personnel-motivational component of the intellectual potential of the enterprise.

Assessment of the impact of the information and innovation component of the intellectual potential of the enterprise (I_{ifin}):

$$I_{ifin} = T_{rfid}, \quad (15)$$

where T_{rfid} – growth rate of funding for innovative activities.

$$T_{rfid} = \frac{F_{idr}}{F_{idb}}. \quad (16)$$

where F_{idz}, F_{idb} – financing of innovative activities for the reporting period and base, thousand USD.

Assessment of the impact of the organizational and legal component of the intellectual potential of the enterprise (I_{orp}):

$$I_{orp} = I_s, \quad (17)$$

where I_s – science intensity index.

$$I_s = \frac{A_{aaa}}{C_{gs} + A_e + B_{sc} + B_o}. \quad (18)$$

where C_{gs} – cost of goods sold, thousand USD; A_e – administrative expenses, thousand USD; B_{sc} – sales costs, thousand USD; B_o – other expenses, thousand USD.

Assessment of the impact of the economic component of the intellectual potential of the enterprise (I_{ec}):

$$I_{ec} = \sqrt{T_{re} * T_{rm}}, \quad (19)$$

where T_{re} – growth rate of R&D efficiency; T_{rm} – growth rate of marketing expenses.

$$T_{re} = \frac{CF}{F_{idsr} + H_{kisr}}, \quad (20)$$

where F_{idsr} – average annual financing of innovative activities, thousand USD; H_{kicp} – average annual unfinished capital investments, thousand USD

$$T_{rm} = \frac{B_{mr}}{B_{mb}}. \quad (21)$$

where B_{mr}, B_{mr} – marketing expenses for the reporting and base period, thousand USD.

Assessment of the impact of the personnel-motivational component of the intellectual potential of the enterprise (I_{pm}):

$$I_{pm} = \sqrt{T_{rk} * T_{rmp}}, \quad (22)$$

where T_{rk} – growth rate of workers with higher education and scientific degrees; T_{rmp} – growth rate of material incentives for the creation of intellectual property objects.

$$T_{rk} = \frac{N_{pvnsr} / N_{pvnsb}}{N_{pvnsb} / N_{pvpb}}, \quad (23)$$

where N_{pvnsr}, N_{pvnsb} – the number of personnel with higher education and scientific degrees for the reporting and base period; N_{pvpr}, N_{pvpb} – the number of industrial and production personnel for the reporting and base periods.

$$T_{rmp} = \frac{M_{ir}}{M_{ib}}. \quad (24)$$

where M_{ir}, M_{ib} – material incentives for the reporting and baseperiod, USD.

Thus, the quantitative and qualitative assessment of intellectual property management takes into account:

– the current state and dynamics of changes in the use of intangible assets in terms of value, role in the property complex (market value of the enterprise), impact on the net flow from operating activities;

– the presence of the intellectual potential of the components, tools and indicators of management.

5. 3. Quantitative and qualitative assessment of intellectual property management on the example of coke-chemical enterprises

To test the proposed scientific and methodological approach, five enterprises were selected whose activities are related to the by-product coke industry – CJSC Avdeevka Coke Plant (Ukraine), CJSC Zaporozhkoks (Ukraine), CJSC Yuzhkoks (Ukraine), Suncoke Energy, Inc. (USA) and JSW S.A. Group (Poland).

The information base for calculations is:

– financial statements and report on the management of Ukrainian enterprises for 2015–2019;

– Report of the Securities Commission on Form 10-K, Washington, DC for 2015–2019, including the Condensed Consolidated Statement of Cash Flows;

– consolidated financial statements of J.S.W S.A. Group for 2015–2019.

All financial information is presented in the open press on the companies' websites [28–32].

To calculate the integral indicator for assessing the management of intangible assets for each of the enterprises, a table with the input data was compiled. An example is given according to the data of CJSC Avdeevka Coke Plant in Table 3. The input data for other enterprises was constructed in a similar way.

Some indicators are calculated as annual averages, that is, as arithmetic mean data at the beginning and end of the period. But in the financial statements, the end of the period is the beginning of the next period, therefore, Table 2 shows the data for 2015 at the beginning and end of the period, while others – only at the end of the period.

Table 3 shows the input data for calculating the integral indicator for assessing the intellectual potential using the example of CJSC Avdeevka Coke Plant (Ukraine), which are compiled similarly to the data in Table 2.

As a result of processing the input data using Microsoft Excel, the integrated indicators of assessment of intangible asset management and intellectual potential of the enterprise (Table 4) for five years for coke plants in Ukraine, USA and Poland are calculated.

From the Table 4 it can be seen that the integral indicator for assessing the management of intangible assets is in the range from 0.24 to 2.51, and the intellectual potential of the enterprise – from 0.14 to 0.87.

Table 2

Input data for calculating the integral indicator for assessing the management of intangible assets of CJSC Avdeevka Coke Plant (Ukraine), million USD

Indicators	2015		2016	2017	2018	2019
	Begin	End	Begin	End	Begin	End
Initial cost of intangible assets	1.7125	1.7	1.35	1.49	1.59	1.62
Balance currency	662	1033.43	733.26	938.07	902.84	707.19
The cost of non-current assets of the enterprise	478.43	448.87	263.88	258.96	207.15	312.61
Profit Loss)	–60.62	179.31	39.42	134.88	124.65	–1.43
Income tax expense	13.81	4.65	–6.42	–23.03	–21.76	1.05
Amortization of intangible assets	1.27	1.43	1.05	1.29	1.45	1.43
Depreciation of fixed assets	3.33	38.68	46.03	62.53	79.38	23.65
Residual value of fixed assets	352.25	325.43	187.30	178.84	170.57	279.26

Table 3

Input data for calculating the integral indicator for assessing the intellectual potential of CJSC Avdeevka Coke Plant (Ukraine), million USD

Indicators	2015		2016	2017	2018	2019
	Begin	End	End	End	End	End
Financing innovation activities	0.002	0.005	0.31	0.15	0.10	0.09
Cost of goods sold	334.13	505.38	395.50	794.31	1069.15	908.15
Administrative expenses	8.00	7.50	4.85	5.69	6.65	8.69
Sales expenses	7.56	10.75	6.73	5.85	10.92	11.23
other expenses	116.38	44.94	17.42	56.38	233.92	174.31
Incomplete capital investments	28.00	25.44	16.12	14.81	17.23	26.00
Marketing expenses	7.56	10.75	6.73	5.85	10.92	11.23
The number of industrial and production personnel, people	237.00	234.44	148.15	145.58	138.19	135.12
Salary, USD	340.25	442.38	319.46	357.92	480.27	524.23

Table 4

Integral indicators for assessing the management of intangible assets and intellectual potential of the enterprise

Enterprise	Year									
	2015		2016		2017		2018		2019	
	I_{ana}	I_{IPA}	I_{ana}	I_{IPA}	I_{ana}	I_{IPA}	I_{ana}	I_{IPA}	I_{ana}	I_{IPA}
Suncoke Energy, Inc.	2.51	0.30	1.04	0.44	1.03	0.55	1.06	0.61	0.57	0.50
JSW S.A. Group	1.04	0.62	0.91	0.55	1.03	0.71	1.11	0.75	0.98	0.70
CJSC Avdeevka Coke Plant	0.46	0.34	0.96	0.87	0.8	0.25	0.84	0.27	0.78	0.2
CJSC Zaporozhkoks	1.28	0.58	0.91	0.31	1.12	0.32	1.27	0.21	0.74	0.26
CJSC Yuzhkoks	1.37	0.41	0.94	0.14	0.92	0.23	0.71	0.29	0.24	0.16

The results of calculating the general integral indicator of the quantitative and qualitative assessment of intellectual property management are given in Table 5.

The integral indicator of the quantitative and qualitative assess of intellectual property management (Table 6) is in the range from 0.197 (CJSC Yuzhkoks in 2019) to 0.919 (CJSC Avdeevka Coke Plant by 2016), which is clearly seen in Fig. 9.

Table 5

Integral indicator of quantitative and qualitative assessment of intellectual property management

Years	J.S.W. A S.A. GROUP	SUNCOKE ENERGY, INC.	CJSC Avdeevka Coke Plant	CJSC Zaporozh-koks	CJSC Yuzh-koks
2015	0.808	0.872	0.398	0.863	0.751
2016	0.714	0.683	0.919	0.535	0.372
2017	0.858	0.757	0.454	0.604	0.465
2018	0.916	0.808	0.484	0.525	0.461
2019	0.836	0.539	0.396	0.444	0.197

Comparison of estimates allows to conclude that Ukrainian coke-chemical enterprises have a low level of IP management. So, in 2015, CJSC Yuzhkoks (Ukraine) had the highest IP management score – 0.751, and in 2019, the lowest – 0.197. In CJSC Zaporozhkoks (Ukraine), a similar trend is observed: in 2015 – 0.863, and in 2019 – 0.444. CJSC Avdeevka Coke Plant (Ukraine) has an unstable IP management system: in 2016 – 0.919 (the highest rating among enterprises), and in 2019 – 0.396. The American Association SUNCOKE ENERGY, INC has insignificant fluctuations – from 0.539 (2019) to 0.872 (in 2015), but there is a trend of gradual deterioration of the situation. Polish Association J.S.W S.A. The Group has the most stable state in IP management, with an integral score ranging from 0.714 (in 2016) to 0.858 (in 2017). In 2018, the integral indicator rose to 0.916, and in 2019 decreased to 0.836, which shows insignificant fluctuations and a high level of IP control.

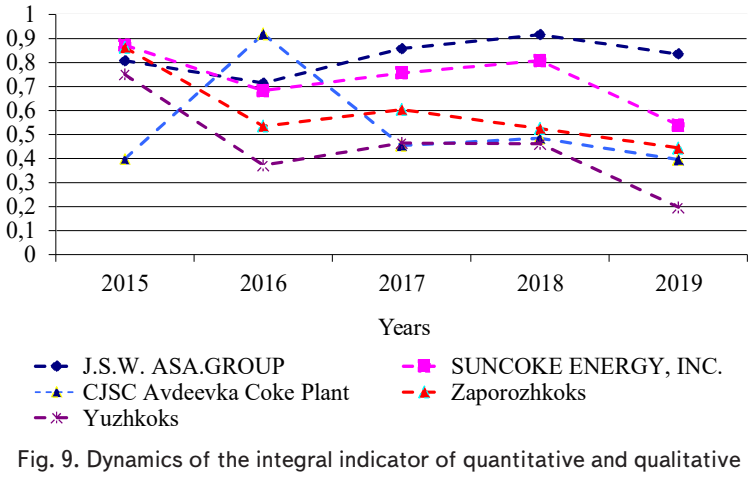

Fig. 9. Dynamics of the integral indicator of quantitative and qualitative assessment of intellectual property management

Based on the calculation of the integral indicator for assessing the level of IP management, let's construct a scale according to the Harrington desirability function [37]:

$$d = d(z_i) = \exp(-\exp(-z_i)), \quad (25)$$

$$z_i = \frac{x_i - x_{ud}^l}{x_{ud}^u - x_{ud}^l}, \quad (26)$$

where z_i – coded value of the i-index; x_i – value of the i-th index of the original array; x_{ud}^l and x_{ud}^u – the lower and upper boundaries of the area "satisfactory" in the existing scale.

Let's group the obtained data on the integral indicator according to the assessment levels: the lower limit is bad, the lower limit is satisfactory, the upper limit is satisfactory, the upper limit is bad (Table 6).

Then, on the basis of the accepted values of the integral indicator for the levels of IP management (Table 6), the assessment scale has the form (Table 7).

Table 6

Integral indicator by levels of intellectual property management

Enterprise	LL bad	LL satisf factory	UL satisf factory	UL good
JSW S.A. Group	0.793871	0.827128	0.893642	0.926898
Suncoke Energy, Inc.	0.674914	0.732196	0.846759	0.904040
CJSC Avdeevka Coke Plant	0.432052	0.530709	0.728022	0.82667
Zaporozhkoks	0.522991	0.594759	0.738294	0.81006
Yuzhkoks	0.359913	0.449711	0.629306	0.719104
Sum	2.783743	3.134504	3.836025	4.186785
Average value	0.556748	0.626900	0.767205	0.837357
Accepted value	0.56	0.63	0.77	0.84

Table 7

Scale for assessing the level of intellectual property management of industrial enterprises

Integral indicator	Ranges of values
Very good	>0.85
Good	[0.78; 0.84]
Satisfactory	[0.64; 0.77]
Bad	[0.57; 0.63]
Very bad	<0.56

So, from the Table 7 it can be seen that the lowest border and worse IP management when the integral indicator is less than 0.56, and the highest limit and the best level of intellectual property management is greater than 0.84.

6. Discussion of the results of a quantitative and qualitative assessment of the management of intellectual property of industrial enterprises

IP management is a strategic and ongoing management process. The first is associated with the formation of a general strategy for the development of the enterprise, and the second – with the assessment of the effectiveness of the use of IP objects, decision-making on the justification of measures to improve management, the achievement of the desired result (Fig. 1). The proposed procedure differs from the assessment methodology:

– asset management [18], as it focuses on the process of using intangible assets and intellectual potential;

– management of IP by components [21], but takes into account the impact on the income of the enterprise, the level of knowledge of personnel, information resources, research of the IP market;

– assessment indicators [20, 26], since the proposed ones relate only to the use of IP objects and intellectual capabilities of the enterprise.

The procedure has common features with methodological approaches regarding methods of protection of rights to IP objects – patenting [4–7], licensing [8].

The objects of intellectual property (IP) of industrial enterprises are shown in the financial statements as intangible assets. The study of intangible assets (Fig. 3) showed that in comparison with Ukrainian coke-chemical enterprises, similar enterprises in Poland and the USA are more valuable. The value of intangible assets grows due to the reflection of goodwill, property rights to subsoil, securities for the sale of energy resources. Ukrainian enterprises only report software in their financial statements. At the same time, the residual value is much lower than the original one (Fig. 2). Intangible assets of coke-chemical enterprises in Ukraine have almost no effect on income (Fig. 4), but only increase the market value of the enterprise. Each business entity seeks to increase the market value on which reputation, creditworthiness and competitiveness depend.

The value of intangible assets of enterprises in Poland and the United States (Fig. 5) has insignificant fluctuations. But, as can be seen from the data of 2019, it does not affect income (the value of intangible assets decreases, while income increases).

Ukrainian coke-chemical enterprises are actively engaged in innovative activities (Fig. 5), which are associated with scientific developments, in a larger volume are carried out by specialized research institutes – SE "UKHIN" and SE "GIPROKOKS". However, as "know-how", utility models or other objects of intellectual property, scientific research is not defined, since it is of an applied nature (Fig. 7) and is not patented.

As a result of the visual-graphical analysis, it was concluded that the intellectual property management system of enterprises is imperfect and does not contribute to improving the efficiency of activities.

To substantiate the directions for improving the IP management system, a structural-logical model for assessing the management of intellectual property of an industrial enterprise is proposed (Fig. 8). The scientific and methodological approach is presented using formulas (1)–(24), which is carried out according to two criteria: quantitative assessment – the level of use of intangible assets; qualitative assessment – the level of intellectual potential (capabilities) of the enterprise.

To assess intangible assets, classical indicators of efficiency were applied, to which an integral indicator of profitability and capital productivity of intangible assets were added, calculated through the net cash flow from operating activities and the profitability of intangible assets.

Assessment of the intellectual potential of an enterprise (Table 1) is based on the use of components (information and innovation, organizational and legal, economic, personnel and motivational), management tools (information, innovation, organizational, legal, financial, marketing, personnel and motivational), and also relevant indicators. Since the assessment of intellectual potential is qualitative, therefore, all indicators are calculated as indicators (growth rates).

CJSC Yuzhkoks (Ukraine) had the highest IP management score – 0.751, and in 2019, the lowest – 0.197. In CJSC Zaporozhkoks (Ukraine), a similar trend is observed: in 2015 – 0.863, and in 2019 – 0.444. CJSC Avdeevsky Coke Plant.

Approbation of the proposed scientific and methodological approach was carried out according to the data of the official websites of CJSC Avdeevka Coke Plant (Ukraine), CJSC Zaporozhkoks (Ukraine), CJSC Yuzhkoks (Ukraine), J.S.W. A S.A. Group (Poland), Suncoke Energy, Inc. (USA). The input data for calculating the integral indicator of the quantitative and qualitative assessment of IP management are given on the example of CJSC Avdeevsky Coke Plant in Tables 2, 3. The results of calculating the indicator for five years (2015–2019) and for the activities of five enterprises are presented in Tables 4–6.

Fig. 9 shows the dynamics of the integral indicator of the quantitative and qualitative assessment of IP management, from which it can be seen that Ukrainian coke enterprises in 2015–2016 had a fairly high level of IP management, but in 2019 there is a sharp deterioration. SUNCOKE ENERGY, INC of America has slight fluctuations in the level of IP management and there is a tendency for the situation to deteriorate. In the Polish association J.S.W. S.A. Group is the most stable state in the management of intellectual property, but recently (2019) the integral indicator of IP management has decreased by 0.08.

On the basis of the calculations, a scale for assessing the quantitative and qualitative level of IP management for industrial enterprises was constructed (Table 7).

The limitations of the proposed scientific and methodological approach can only relate to the lack of data on the quantitative and qualitative assessment of the level of IP management. Approbation of the approach on the example of coke-chemical enterprises showed that all indicators in the financial statements of enterprises in Ukraine, Poland and the USA are used to calculate the integral indicator.

The above studies should be developed in the area of strategic IP management.

7. Conclusions

1. The essence of the concept of "IP management", which covers strategic and current asset management, has been determined. Strategic IP management is part of the enterprise strategy – this is a separate research topic that is not related to the quantitative and qualitative assessment of IP management. A procedure for the current management of IP has been developed, which contains fifteen stages. Management is based on the analysis of the state of use of intangible assets and the impact on the income of the enterprise, quantitative and qualitative assessment, justification of measures and options for improvement through the creation or acquisition, the choice of a method for protecting rights, drawing up a report on IP management. The procedure differs from others in that it is complex and is based on a scientific and methodological approach that takes into account the state and prospects for the development of IP of an industrial enterprise.

2. The coke-chemical industry was not chosen by chance, as it is the basis of the processing industry, namely: the metallurgical complex, mechanical engineering and others. Research on the use of intellectual property objects conducted on the example of CJSC Avdeevka Coke Plant (Ukraine), CJSC Zaporozhkoks (Ukraine), CJSC Yuzhkoks (Ukraine),

J.S.W. A S.A. Group (Poland), Suncoke Energy, Inc. (USA) showed ambiguity. Ukrainian enterprises use only software as objects of intellectual property, therefore they have little impact on the value of assets, enterprises and income. Ukrainian by-product coke enterprises carry out innovative activities through the scientific work of SE "UKHIN" and SE "GIPROKOKS", which is of an applied nature. Polish Association of Coke Enterprises J.S.W. A S.A. Group and the American association Suncoke Energy, Inc use goodwill, property rights to subsoil, environmental permits and operational certificates as intellectual property objects. The cost of intangible assets, in the form of which intellectual property objects are presented in the financial statements, of the Polish and American associations are more than nine times higher than the Ukrainian ones.

3. The developed scientific and methodological approach to quantitative and qualitative assessment of intellectual property management of industrial enterprises is based on a structural and logical model, which is compiled according to two criteria – the level of use of intangible assets – IP objects, and the level of intellectual potential (capabilities) of the enterprise. Evaluation of the efficiency of intangible assets is carried out according to the degree of amortization, according to the place in the property complex, according to the increasing ratio of assets and balance sheet currency, according to the increasing profitability and profitability. Added to the specified quantitative assessment indicators is the indicator of net cash flow from operating activities (cash-flow), which characterizes the availability of net profit and amortization of assets, including intangible ones. The overall quantitative assessment of intangible assets is calculated as an integral coefficient characterizing the existing level of IP management at the enterprise. A qualitative assessment of IP management shows the intellectual capabilities of an enterprise in the near future and is complex, since it is carried out in terms of components, tools and indicators. The components of the intellectual potential include: information and innovation, organizational and legal, economic, personnel and motivational. The components are deciphered in instruments, and the instruments are in indicators. The indicators characterize the index of the science intensity of products and the growth rate of financing for innovative activities, the effectiveness of R&D, marketing costs, employees with higher education and scientific degrees, encouraging employees to engage in intellectual activity. So, the qualitative assessment of IP management is carried out using an integral indicator for the components of potential.

4. Approbation of the IP management assessment model was carried out on the example of Ukrainian, Polish and American coke-chemical enterprises for the period from 2015 to 2019. The proposed model is based on the analysis of intangible assets in general, so the study did not consider the results of using individual IP objects. Research has shown that Ukrainian coke enterprises have an unstable level of IP management, which tends to decline in 2019. The IP management level of the American Association SUNCOKE ENERGY, INC. has insignificant fluctuations – from 0.872 (in 2015), to 0.539 (2019), but there is a tendency for the situation to worsen. Integral indicator of the Polish association J.S.W S.A. Group is in the range of 0.714 in 2016 to 0.916 in 2018, and in 2019. Decreased to 0.836. Consequently, the level of IP management in the association is quite high and has minor fluctuations. Based on the results obtained, a scale for assessing the level of IP management by the Harrington function was constructed. The proposed quantitative and qualitative assessment of IP management can be applied to other industrial enterprises whose activities are related to the introduction of innovative products, property and copyrights, trademarks and other intellectual property objects.

References

1. Holgersson, M., van Santen, S. (2018). The Business of Intellectual Property: A Literature Review of IP Management Research. Stockholm Intellectual Property Law Review, 1 (1), 44–63. Available at: https://papers.ssrn.com/sol3/papers.cfm?abstract_id=3202847
2. Adner, R., Kapoor, R. (2010). Value creation in innovation ecosystems: how the structure of technological interdependence affects firm performance in new technology generations. Strategic Management Journal, 31 (3), 306–333. doi: https://doi.org/10.1002/smj.821
3. Teixeira, A. A. C., Ferreira, C. (2019). Intellectual property rights and the competitiveness of academic spin-offs. Journal of Innovation & Knowledge, 4 (3), 154–161. doi: https://doi.org/10.1016/j.jik.2018.12.002
4. De Rassenfosse, G., Palangkaraya, A., Webster, E. (2016). Why do patents facilitate trade in technology? Testing the disclosure and appropriation effects. Research Policy, 45 (7), 1326–1336. doi: https://doi.org/10.1016/j.respol.2016.03.017
5. Soranzo, B., Nosella, A., Filippini, R. (2017). Redesigning patent management process: an Action Research study. Management Decision, 55 (6), 1100–1121. doi: https://doi.org/10.1108/md-04-2016-0226
6. Holgersson, M., Wallin, M. W. (2017). The patent management trichotomy: patenting, publishing, and secrecy. Management Decision, 55 (6), 1087–1099. doi: https://doi.org/10.1108/md-03-2016-0172
7. Modic, D., Hafner, A., Damij, N., Cehovin Zajc, L. (2019). Innovations in intellectual property rights management. European Journal of Management and Business Economics, 28 (2), 189–203. doi: https://doi.org/10.1108/ejmbe-12-2018-0139
8. Belingheri, P., Leone, M. I. (2017). Walking into the room with IP: exploring start-ups' IP licensing strategy. Management Decision, 55 (6), 1209–1225. doi: https://doi.org/10.1108/md-04-2016-0227
9. Aloini, D., Lazzarotti, V., Manzini, R., Pellegrini, L. (2017). IP, openness, and innovation performance: an empirical study. Management Decision, 55 (6), 1307–1327. doi: https://doi.org/10.1108/md-04-2016-0230
10. De Vries, G., Pennings, E., Block, J. H., Fisch, C. (2016). Trademark or patent? The effects of market concentration, customer type and venture capital financing on start-ups' initial IP applications. Industry and Innovation, 24 (4), 325–345. doi: https://doi.org/10.1080/13662716.2016.1231607
11. Brem, A., Nylund, P. A., Hitchen, E. L. (2017). Open innovation and intellectual property rights. Management Decision, 55 (6), 1285–1306. doi: https://doi.org/10.1108/md-04-2016-0223

12. Lima, F. V. R., Santos, J. A. B. dos. (2018). Intellectual Property Management in Small and Medium-Sized Enterprises. International Journal for Innovation Education and Research, 6 (9), 109–127. doi: https://doi.org/10.31686/ijier.vol6.iss9.1161
13. Valdez-Juárez, L. E., García-Pérez-de-Lema, D., Maldonado-Guzmán, G. (2018). ICT and KM, Drivers of Innovation and Profitability in SMEs. Journal of Information & Knowledge Management, 17 (01), 1850007. doi: https://doi.org/10.1142/s0219649218500077
14. Maldonado-Guzmán, G., Lopez-Torres, G. C., Garza-Reyes, J. A., Kumar, V., Martinez-Covarrubias, J. L. (2016). Knowledge management as intellectual property. Management Research Review, 39 (7), 830–850. doi: https://doi.org/10.1108/mrr-02-2015-0024
15. Miyashita, S., Katoh, S., Anzai, T., Sengoku, S. (2020). Intellectual Property Management in Publicly Funded R&D Program and Projects: Optimizing Principal–Agent Relationship through Transdisciplinary Approach. Sustainability, 12 (23), 9923. doi: https://doi.org/10.3390/su12239923
16. Miozzo, M., Desyllas, P., Lee, H., Miles, I. (2016). Innovation collaboration and appropriability by knowledge-intensive business services firms. Research Policy, 45 (7), 1337–1351. doi: https://doi.org/10.1016/j.respol.2016.03.018
17. Córdova, F. M., Durán, C. A., Galindo, R. (2016). Evaluation of Intangible Assets and Best Practices in a Medium-sized Port Community. Procedia Computer Science, 91, 75–84. doi: https://doi.org/10.1016/j.procs.2016.07.043
18. Varenyk, V. M., Yevtushenko, Ya. S. (2018). Diagnostic analysis of company assets management efficiency. Skhidna yevropa: ekonomika, biznes ta upravlinnia, 1 (12), 117–122. Available at: http://www.easterneurope-ebm.in.ua/journal/12_2018/22.pdf
19. Semenova, V. G. (2015). Analysis of efficiency of intellectual property companies. Economics: time realities, 2 (18), 263–268. Available at: http://economics.opu.ua/files/archive/2015/n2.html
20. Semenova, V. (2015). Mathematical model of efficiency evaluation components of enterprise intellectual property management. Ekonomika ta derzhava, 8, 58–62. Available at: http://www.economy.in.ua/?op=1&z=3268&i=12
21. Semenova, V. G. (2015). Components of the system of intellectual property management enterprises. Economics: time realities, 3 (19), 159–165. Available at: https://www.elibrary.ru/item.asp?id=26342638
22. Pavlenko, T. V. (2012). Process of intellectual property management. Ekonomichnyi visnyk NTUU «KPI», 9, 266–270. Available at: https://ela.kpi.ua/handle/123456789/2983
23. Kuchumova I. Y. (2013). Intellectual Capital in the System of Enterprise Management. Business Inform, 12, 357–364. Available at: http://nbuv.gov.ua/UJRN/binf_2013_12_65
24. Karnaukh, K. V. (2010). Suchasnyi stan upravlinnia obiektamy promyslovoi vlasnosti v innovatsiyniy diyalnosti sudnobudivnykh pidpryiemstv. Ekonomika pidpryiemstva ta upravlinnia vyrobnytstvom, 2 (54), 64–65. Available at: http://www.ed.ksue.edu.ua/ER/knt/e102_54/e102karn.pdf
25. Husakovska, T. O. (2009). Upravlinnia intelektualnoiu vlasnistiu pidpryiemstva. Kharkiv, 20. Available at: http://dspace.puet.edu.ua/handle/123456789/9158
26. Semenova, V. H. (2016) Upravlinnia intelektualnoiu vlasnistiu pidpryiemstva: protsesnyi pidkhid. Odessa: Odeskyi natsionalnyi ekonomichnyi universytet, 417. Available at: http://dspace.oneu.edu.ua/jspui/handle/123456789/5044
27. Sylka, I. V. (2019). The Theoretical Foundations of Management of Intellectual Property of Industrial Enterprises. Business Inform, 7, 144–153. doi: https://doi.org/10.32983/2222-4459-2019-7-144-153
28. PrAT "Avdiyivskyi koksokhimichnyi zavod". Available at: https://akhz.metinvestholding.com/ua/about/info
29. PrAT "Zaporizhkoks". Available at: https://zaporozhcoke.com/informacija-dlja-akcionerov/ustav-obshhestva/?lang=ru
30. PrAT «Yuzhkoks». Available at: https://bkoks.dp.ua/information_shareholders/
31. Jastrzębska Spółka Węglowa S.A.'s Investor Relations website. Available at: https://www.jsw.pl/en/investors-relations
32. SunCoke Energy, Inc. Available at: http://www.suncoke.com/English/investors/sxc/overview/default.aspx
33. Pro zatverdzhennia Natsionalnoho polozhennia (standartu) bukhhalterskoho obliku. Dokument z0750-99. Available at: https://zakon.rada.gov.ua/laws/show/z0750-99#Text
34. UNPA Ukrkoks. Available at: http://ukrkoks.com/
35. Shatskova, L. P. (2014). Pokazateli sostoyaniya i effektivnosti ispol'zovaniya nematerial'nyh aktivov. Mezhdunarodniy ekonomicheskiy forum 2014. Available at: https://be5.biz/ekonomika1/r2014/4097.htm
36. Raiko, D., Podrez, O., Cherepanova, V., Fedorenko, I., Shypulina, Y. (2019). Evaluation of quality level in managing the development of industrial enterprises. Eastern-European Journal of Enterprise Technologies, 5 (3 (101)), 17–32. doi: https://doi.org/10.15587/1729-4061.2019.177919
37. Volkov, K., Volkov, S., Kazakova, N. (2017). Improving Quality Score function desirability Harrington. Modern Information Security, 1, 103–108. Available at: http://journals.dut.edu.ua/index.php/dataprotect/article/view/1419