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SUBSTANTIATION OF METHODICAL APPROACHES TO COST ESTIMATION OF INNOVATIVE TECHNOLOGIES

Об'єктом даної роботи є вартісне оцінювання технологій, розроблених в університетах. Одним із найпроблемніших аспектів реалізації трансферу інноваційних технологій з університетів у бізнес-середовище в Україні є відсутність у необхідній і достатній кількості методичних розробок, спрямованих на ефективне оцінювання вартості технологій. Існуючі напрацювання здебільшого носять галузевий або локальний характер, є фрагментарними. Позаяк, вартісне оцінювання є основою успішної комерціалізації технологій та їх ринкового поширення. З огляду на це, означена проблематика є науково і практично значущою.

У ході наукової роботи розглянуто чинні підходи і методи оцінювання вартості інноваційних технологій. Проаналізовано нормативно-правові документи, що регламентують порядок оцінювання інноваційних технологій, розроблених в університетах. Уточнено витратний метод оцінювання вартості інноваційних технологій шляхом обґрунтування виразів для планування показників витрат та застосування запропонованих індивідуальних індексів цін. Перевагами уточненого методу оцінювання вартості технологій є вищий рівень точності прогнозування економічних елементів витрат у складі собівартості об'єкта. Запропоновано експлікації методів вартісного оцінювання технологій, розроблених в університетах, із методами ціноутворення. Методичні експлікації можуть бути використані як інструмент для прийняття рішень щодо доцільності започаткування тих чи інших науково-дослідних або дослідно-конструкторських робіт. Розроблено матрицю співвідношення показників вартісної оцінки, ціни і прибутку на засадах експлікацій методів вартісного оцінювання та ціноутворення.

Зазначене є базисом для розвитку інших методів економічного оцінювання технологій.

Запропоновані методичні підходи дають змогу обґрунтовувати управлінські рішення щодо розвитку технологій (від етапу зарахування на баланс університетів до етапу вибору сценарію комерціалізації, трансферу та поширення даних технологій на ринку). А також провадити ефективне стратегічне планування технологічного поступу університету тощо.

Ключові слова: *методи економічного оцінювання технологій, методичні експлікації, трансфер інноваційних технологій, науково-технічна продукція.*

1. Introduction

Changes in the world economy, caused by the course of the IV Industrial Revolution, put forward new requirements to solve problems associated with development and transfer of innovative technologies. In recent years, one of the main factors of technological development of the countries of the world is the transfer of technologies originating from universities. Innovative technologies generated by universities and successfully introduced into the market are becoming an increasingly important source of economic prosperity for both the universities themselves and for the regions and countries where they operate. In this context, it is important to effectively justify the cost of technology, to determine the scenario of their commercialization, providing a link between science and production.

The problem of value estimation of innovative technologies is being actively studied by world scientists and practitioners. The importance of this issue is emphasized in the documents of the leading international organizations engaged in the study of technological development of countries. For example, the estimation of innovative technologies is described in the context of the methodology for determining the competitiveness index of countries of the world [1], which is annually developed by the World Economic Forum. In particular, within the framework of the 12th component of the «Innovation» of this index, attention is focused on assessing the transfer of technologies originating from the university environment. In the «Global Information Technology Report 2016» [2] of this organization, considerable attention has been paid to the engine of modern technology transfer and the confirmation of the role of high-tech enterprises created by universities. At the same time, many questions arise related to the estimation of technologies and their support during the transfer to the business environment.

In five groups of indicators «European scoreboard of innovation development» [3], attention is paid to the assessment of interaction between research institutions and business. The effectiveness of such interaction primarily depends on economically justified value indicators, which are transferred from research institutions to business.

The complexity of modern market demand for technology assessment is growing faster than the corresponding methods are being developed for this. At present, a large number of manuals and models for technology estimation have been developed in the world. In particular, the Oslo Guidelines (2002), the Frascati Manual (2015), the Canberra Manual (1995), the NASA Model, the S. Muegge Model for the Preparation of Technological Products, the J. N. Behrman and H. W. Wallender Model, the B. Bozeman model of conditional effectiveness of technology transfer, etc.

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However, in Ukrainian realities it is not always possible to apply these developments, since they are more in line with the legal, socio-economic, political features of their countries of origin.

The Law of Ukraine «On scientific and scientific and technical activities» [4] stipulates such types of technologies originating from the university: scientific result, scientific and applied result and scientific and technical products. Universities can transfer various types of technologies. Traditionally, Ukraine is considered a state with a strong scientific potential, recognized in the world by scientific schools. As a rule, universities submit the largest part in Ukraine from the total number of applications for the issuance of titles of protection. However, with a sufficiently high potential for technology generation, Ukrainian universities generally do not receive sufficient commercial results from this. The imperfection of the current methodological base for technology assessment and the overwhelming absence of technology transfer strategies in universities slow down their transfer to business environment.

In recent years, Ukrainian legislation has undergone significant progressive changes aimed at improving the efficiency of expertise and estimation of technologies developed in universities. However, it remains an open question to find such methods and models of technology estimation, on the one hand, would take into account successful international practices, on the other, Ukrainian specifics.

2. The object of research and its technological audit

The subject of this research is methodical approaches to the estimation of innovative technologies. *The object is* the estimation of technologies developed in universities.

The Law of Ukraine «On scientific and scientific and technical activities» determines that scientific (scientific and technical) products are scientific and (or) scientific and applied result intended for implementation [4]. According to the content of the law, scientific and technical products received from universities, which are the result of research and development (R&D), must be suitable for implementation and generate commercial (social, environmental, etc.) effect. This is reflected in P(S)BO 8 «Intangible assets» [5], according to which the intangible asset, which is contained in the scientific and technical products, is reflected in the balance sheet of the enterprise in case of probability of obtaining future economic benefits, associated with the use of this asset.

Importance of accounting for the benefits in the development of technology and their transfer is confirmed by a number of other regulatory and legislative documents of Ukraine:

– The Law of Ukraine «On the state regulation of activities in the sphere of technology transfer»;
– Resolution of the Cabinet of Ministers of Ukraine of 03.07.2013 No. 472 «On approval of the procedure for registration of technologies and their components, created or purchased for budgetary funds or created or acquired by enterprises of state ownership» and others.

An estimation of scientific and technical products and determination of its economic efficiency is regulated by the Law of Ukraine «On Scientific and Scientific and Technical Expertise» [6], where it is stated that scientific and technical products are subject to examination, which is initiated and conducted by organizations and institutions, this issue. It also stipulates that «... higher education institutions certified by the central body of executive power that ensures the formation of state policy in the field of science (...) can carry out specialized expert activities without additional state accreditation on the basis of the statutory provisions by which such activities are supposed» [6]. Despite this, and taking into account the opportunities, gives the universities the Law of Ukraine «On Higher Education» – to be founders/co-founders of other legal entities, they can form educational, educational, research and production complexes, scientific parks and be part of the consortium [7]), the format of academic entrepreneurship of Ukrainian universities is determined. From such positions, the lever of successful entrepreneurial activity of universities is an effective estimation of the technologies generated by them.

The main normative and legal documents on technology assessment are:

– The Law of Ukraine «On the estimation of property, property rights and professional appraisal activities in Ukraine» of 12.07.2001, No. 2658;
– National Standard No. 1 «General Basis for the Assessment of Property and Property Rights» of 10.09.2003, No. 1440;
– National Standard No. 4 «Assessment of Intellectual Property Rights» of 03.10.2007, No. 1185;
– Methodology for assessing property rights of intellectual property, approved by the Order of the State Property Fund of Ukraine of 25.06.2008, No. 740.

In general, in Ukraine there are more than 40 regulations concerning the estimation of both technologies in general and specifically intangible assets in their composition. The Commission for International Estimation Standards published International Estimation Rule 4 «Estimation of Intangible Assets» based on IES 1 «Market Value as the Basis for Estimation», IES 2 «Estimation Bases Other than Market Value», IES 3 «Estimation Report». These normative documents define:

– legal framework for assessing property, property rights and professional appraisal activities in Ukraine;
– ensuring an independent assessment of property in order to protect the legitimate interests of the state and other subjects of legal relations in matters of estimation of property, property rights and the use of their results.

Traditionally, technology estimation is divided into two main stages:

1) qualitative estimation (reflects the properties of technology, the level of interaction of its individual components with other resources, etc.);

2) quantitative estimation (shows how to establish a qualitative estimation of assets).

According to the National Standard 4 «Evaluation of Property Rights of Intellectual Property» approved by Decree of the Cabinet of Ministers of Ukraine of 03.10.2007, No. 1185 [8], it is recommended to use methodological approaches recognized in national and international practice for estimation of technologies:

– expensive;
– profitable (income);
– market (comparative);
– combined.

The study of approaches to determining the value of technology has shown how traditional methodological approaches are reflected in normative and methodological documents developed and approved by state authorities (Table 1).

The variety of normative and legal documents is determined both by the specifics of technologies, their individual characteristics, and by various estimation purposes and by subjects performing estimation.

Table 1

Normative and legal documents, regulating the order of technology estimation

Document	Document (body) to which the document was approved (developed)	Key characteristic of the document	Approaches (methods) used to assess technology within a document
International Financial Reporting Standard 38 (IAS 38). Intangible assets [9]	International Financial Reporting Standards (IFRS), including International Accounting Standards (IAS) and explanations issued by the Council on International Accounting Standards, as amended (as of 01.01.2012)	Determines the order of accounting for intangible assets	Cost, income
A model provision for the planning, accounting and calculation of the cost of research and development [10]	Resolution of the Cabinet of Ministers of Ukraine (20.07.1996, No. 830)	Establishes uniform methodological bases for determining the cost of R & D in organizations, they are carried out, regardless of the forms of ownership and management	Cost (normative)
The procedure for determining the estimated value of objects of intellectual property rights (OIPR) that are state-owned or created (purchased) for public funds, with a view to enrolling in accounting [11]	The Order of the State Property Fund of Ukraine (13.12.2005 No. 3162) was registered with the Ministry of Justice of Ukraine on 25.04.2006, No. 479/12353	Standardized estimation of the appraisal of the estimated value of intellectual property rights that are state-owned or created (purchased) for public funds	Cost approach, in particular: – method of direct playback; – substitution method
Methodology for estimation of property rights of intellectual property [12]	The Order of the State Property Fund of Ukraine (25.06.2008, No. 740) was registered with the Ministry of Justice of Ukraine on 06.08.2008, No. 726/15417	It is used to evaluate the property rights of intellectual property by the subject of appraisal activity – the business entity in cases defined by art. 7 of the Law of Ukraine «On the estimation of property, property rights and professional appraisal activities in Ukraine»	Apply methodical approaches and methods that most fully meet the specific purpose of the estimation, the type of value in the presence of reliable information sources. Profitable approach (using the indirect capitalization method (cash flow discounting) and the method of direct capitalization of income. Comparative approach. Cost-based approach: – direct playback method; – substitution method; – residue method
Methodology of property estimation [13]	Decree of the Cabinet of Ministers of Ukraine of 10.12.2003, No. 1891 (as amended by the Resolution of the Cabinet of Ministers of Ukraine of 25.11.2015, No. 1033)	Standardized estimation for evaluation of objects of state and municipal property rights, property of economic entities with state (municipal) shares in the authorized (reserve) capital in cases when such objects are objects of economic, civil and other legal relationships, except for cases of leasing and concession of objects of state and municipal property	Cost, income, comparative
National Standard No. 1 «General Basis for Estimation of Property and Property Rights» [14]	Decree of the Cabinet of Ministers of Ukraine (10.09.2003, No. 1440)	It is mandatory for application in the estimation of property and property rights by the entities of the appraisal activity, as well as by persons who, in accordance with the legislation, review the reports on property estimation	Cost, comparative
National Standard No. 4 «Estimation of Property Rights of Intellectual Property» [8]	Resolution of the Cabinet of Ministers of Ukraine of 03.10.2007, No. 1185	Obligatory for application by estimation entities when assessing property rights of intellectual property, as well as by persons who, in accordance with legislation, review reports	Income (method of indirect capitalization (discounting cash flow) and the method of direct capitalization of income); comparative; cost
The methodology for determining the economic efficiency of costs for research and development and their introduction into production [15]	Ministry of Economic Development and Trade of Ukraine, Department of Investment and Innovation Activities (13.10.2006)	The methodology for determining the cost-effectiveness of research and development and their implementation, designed to determine the effectiveness of applied scientific and technological developments as potential innovations at all stages of their life cycle – R&D, the creation of prototypes, their testing and introduction into production	Cost, comparative

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The importance of the problem of technology estimation developed in universities, given the promise of their commercialization, is confirmed by the study of models of the functioning of universities in Ukraine [16]. Its results confirm that since the beginning of the XXI century in Ukraine dominates the German model of the functioning of universities, in which universities introduce progressive R&D into the needs of the market and develop advanced scientific and educational programs to stimulate such work.

3. The aim and objectives of research

The aim of research is substantiation of methodological approaches to the cost estimation of innovative technologies developed at universities.

To achieve this aim, the article has the following objectives:

1. To clarify the cost method of cost estimation of technology by means of visibility for the planning of cost indicators and the application of individual price indices.

2. To offer methodical explications of cost estimation of technology from pricing methods.

3. To develop a matrix of the ratio of estimation indicators, prices and profits based on explications of methods of cost estimation and pricing.

4. Research of existing solutions of the problem

The subject of cost estimation of technology and finding ways to successfully launch it into the market is a time requirement. Problems of cost estimation of scientific and technical products and intangible assets in particular are devoted to works [17–19]. However, these works do not reveal specific methodological tools for assessing the value of innovative technologies in the conditions of their transfer from universities to the business environment.

Themes of commercialization of research results, originating from the universities are represented in the works [20–22]. Approaches to the estimation of technologies in the context of academic entrepreneurship are mentioned in works [23–25]. However, scientists are mainly considering organizational and methodological aspects of commercialization and technology transfer. Instead, attention is not paid to specific methods of economic estimation of technologies.

The justification of various aspects of enrollment on the balance of technology universities is given in the papers [26–29]. Also partly the question is disclosed in the writings [28, 30].

At the same time, in terms of the number of developments of scientists and practice, there are still no comprehensive methodological recommendations for the effective estimation of the variability of technology, developed in universities. The question of establishing the cost estimation of scientific and technical products when it is transferred to the university's balance remains open. In particular, in the case of the re-examination of rights to objects of industrial property rights, the provision of scientific and technical products in the form of contributions to the statutory fund jointly establishment of an enterprise, sale under a license, etc. Available methodological developments are fragmentary.

The spacing of the scientific search makes it possible to argue that the cost estimation of technology, developed in universities, now represents one of the most important problems in the area of academic entrepreneurship, as it is the basis for the further transfer of these technologies.

No doubt, there are many situations involving the cost estimation of technology and the objectively impossible dermal ones to describe a particular. However, it is advisable to create a certain set of formalized approaches that can be operated in different situations. There is a need to develop a technology estimation methodology that not only took into account the technology estimation, but would also provide different explications for such estimation.

5. Methods of research

To achieve this aim and solve established problems, such scientific methods are used:

– method of analysis in the study of statistical data, scientific works, regulatory and legal field for cost estimation of innovative technologies in conditions of transfer from universities to the business environment;
– method of synthesis in the formation of explications of estimation methods and methods of pricing technology;
– method of structural and logical analysis in determining individual indices and corrective indicators of cost elements in the cost of innovative technologies;
– graphical method for visualization of the ratio of options for expected income when applying some explication of estimation methods and methods of price formation;
– method of generalization in the formation of conclusions on the justification of methodological approaches to the estimation of innovative technologies.

6. Research results

Cost estimation of technology developed in universities is the basis for justifying the economic efficiency of the introduction of these technologies in the economic turnover of universities and, consequently, further operations with them. According to the «Procedure for determining the estimated value of objects of intellectual property rights that are in state ownership or were created (purchased) for public funds, with the purpose of enrolling in accounting» [11], specialists should be guided by a cost approach. Proceeding from the fact that university technologies contain, among other things, objects of industrial property law, which are largely impossible to assess by the methods of this approach, let's consider it incorrect to fix only this approach in this document. Not always the initial cost of technology can be reliably determined, based on the actual costs of its development and bringing it to commercial use with allowance for depreciation. This situation led to the need to consider a more costly approach and make certain adjustments aimed at improving the situation.

It is necessary to take into account that the object of industrial property law prevails among other objects within the technology of universities. Its estimate (C_e) in the framework of the cost approach can be defined as follows [27]:

$$C_e = \left(\sum_{t=t_i}^{t_k} C_t \cdot \sigma_t \right) \cdot K_a \cdot K_b, \quad (1)$$

where C_t – cost estimation of the industrial property object in the t-th year of the settlement period, monetary

unit; t_i – the initial year of the accounting period (the initial year of the operation of exclusive rights to the industrial property object); t_f – the final year of the accounting period (the year of calculating the value of the industrial property object); σ_t – the coefficient of bringing different-valued cost estimates to the level of the calculated year; K_a – the coefficient that takes into account the degree of moral aging of the industrial property object (for inventions, industrial designs and utility models); K_b – bonification coefficient (coefficient of technical and economic significance, only for inventions) of the industrial property object.

However, this technique can be used only to determine the approximate value of the industrial property object. On the one hand, it involves taking into account the difference in cost estimates, their erection to the level of the calculated year. On the other hand, to predict future periods of certain types of costs planned for the development, production and promotion of industrial property, in practice, objectively difficult, and sometimes impossible. To effectively evaluate the value of industrial property objects, there is a need to justify the costs in the framework of this approach.

It is proposed to update the cost parameters for the years of the calculation period by applying the corrective elements of the current prices. Most of all, current prices are set for products with a long production process. During a long production period, there are almost always changes in prices caused by environmental factors: an increase in the minimum wage, fluctuations in inflation, fuel and raw materials prices, electricity, and the like. So, accounting for annual changes in those items of expenditure that have the largest share in cost, will contribute to its precise form. Mathematically, the method for determining the current price (P_c) is described thus:

$$P_c = P_{bas} \cdot \left(S_1 + S_2 \cdot \frac{m_1}{m_0} + S_3 \cdot \frac{o_1}{o_0} + S_4 \cdot \frac{e_1}{e_0} \right) \div 100, \quad (2)$$

where P_{bas} – the base price of the product, monetary unit; S_1 – specific weight of fixed costs in cost price, %; S_2 – specific weight of expenses for raw materials and materials, %; S_3 – specific weight of labor costs, %; S_4 – specific weight of expenses for fuel and energy, %; m_1 and m_0 – the cost of raw materials and materials in the reporting and reference periods, gr. unit; o_1 and o_0 – the cost of pay in the reporting and reference period, monetary unit; e_1 and e_0 – the cost of fuel and energy in the reporting and reference periods, monetary unit.

Let's note that expression (2) describes a two-year period: the reference and reporting years are indicated. Period, of course, can be long. In particular, a long production process is characteristic for the development and manufacturing of industrial property objects. Using method (2), costs in the cost of technology can be adjusted using appropriate coefficients. However, it is necessary to specify the instruments for adjusting the economic elements of the conditional variables and conditionally fixed expenses.

Drawing on theoretical and practical research of scientists, tools for adjusting economic elements of costs in the cost of technology have been identified and considered. In particular, the inflation index reflects depreciation of the national monetary unit (determined by reference books, which are annually developed and submitted by the State Statistics Service of Ukraine). Accounting for this indicator is important because it uses consumer and wholesale price indicators, indicators of monthly, quarterly and annual changes in the monetary costs necessary to purchase consumer goods and services by the population. This is an instrument necessary to adjust both the conditionally variable and the conditionally fixed costs of manufacturing an industrial property object at the university.

Important factors in cost management are accounting for changes in the value of the minimum wage and, accordingly, all types of charges on it, and changes in prices for fuel and electricity (all figures are determined from data from the State Budget of Ukraine).

In addition, the indices of cost (revenue, turnover) of the enterprise and indices of the physical volume of products are used. A certain influence is exerted by the risk factor at various stages of the production process.

Additionally, it is expedient to propose an individual index of the university to determine the change in prices for materials used by it for manufacturing this industrial property object for a certain period of time. Let's offer the expression:

$$I_m = \frac{P_{n1}^m}{P_{n0}^m}, \quad (3)$$

where I_m – an individual price index for the materials of the enterprise; P_{n1}^m – price of the material (it is reasonable to count on each corresponding n-material from the set of n-materials) in the reporting year, monetary unit; P_{n0}^m – the price of materials (n-material from the set of n-materials) in the base year, monetary unit.

This index is expedient for use in the part m_1/m_0 of expression (2), which will allow to clarify the change in the value of individual economic elements of expenses of «materials» and to form the index m in this technique with high accuracy.

A similar index for the content is useful application and clarification of the economic elements of the item «raw materials» in the cost of production, for example:

$$I_r = \frac{P_{n1}^r}{P_{n0}^r}, \quad (4)$$

where I_r – the individual price index for the raw materials of the enterprise; P_{n1}^r – the price of raw materials (it is advisable to count on each corresponding n-kind of raw materials from the set of its n-types) in the reporting year, monetary unit; P_{n0}^r – the price of raw materials (n-raw material from a variety of n-types of raw materials) in the base year, monetary unit.

When using expression (2), the question arises for determining the base price of the product (P_{bas}). There are many methods of establishing such price, depending on the specifics of the production process, enterprise or industry. However, for the case with the formation of a base price for an industrial property object that is considered innovative, insufficient attention has been paid to the existing scientific and practical literature.

In the case of the formation of a base price for an improved, improved object of industrial property, it is expedient to apply parametric pricing, in particular, the method of sequential accounting of numerical values of parameters in the price.

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Mathematically, the model of parametric pricing for a new industrial property object has the form:

$$\frac{P_{new}}{P_{ex}^{i}} = \left(\frac{\mathrm{Pr}_{new}}{\mathrm{Pr}_{ex}^{i}} \right)^{k}, \quad (5)$$

where P_{new} – the price of new products, which it is necessary to determine, monetary unit; P_{ex}^{i} – price of the i-th existing product, which is known and used as a basis for comparison, gr. unit; Pr_{new}, Pr_{ex}^{i} – the values of the parameters of the new product and i-th existing products; k – power factor of braking, taking into account the backlog of the product price from the increase in the numerical value of a certain selected parameter.

The above expression takes into account the correction factors for each of the products participating in the comparison. In particular, if there are parameters a, b, c, d for comparing the industrial property object with other similar products, then the correction factors, for example, for the four compared products are defined as follows:

1) parameter a:

$$K_{ex}^{1a} = \left(\frac{a^{new}}{a^{1\,new}} \right)^{k}; \; K_{ex}^{2a} = \left(\frac{a^{new}}{a^{2\,ex}} \right)^{k};$$

$$K_{ex}^{3a} = \left(\frac{a^{new}}{a^{3\,ex}} \right)^{k}; \; K_{ex}^{4a} = \left(\frac{a^{new}}{a^{4\,ex}} \right)^{k}; \quad (6)$$

2) parameter b:

$$K_{ex}^{1b} = \left(\frac{b^{new}}{b^{1\,ex}} \right)^{k}; \; K_{ex}^{2b} = \left(\frac{b^{new}}{b^{2\,ex}} \right)^{k};$$

$$K_{ex}^{3b} = \left(\frac{b^{new}}{b^{3\,ex}} \right)^{k}; \; K_{ex}^{4b} = \left(\frac{b^{new}}{b^{4\,ex}} \right)^{k}; \quad (7)$$

3) parameter c:

$$K_{ex}^{1c} = \left(\frac{c^{new}}{c^{1\,ex}} \right)^{k}; \; K_{ex}^{2c} = \left(\frac{c^{new}}{c^{2\,ex}} \right)^{k};$$

$$K_{ex}^{3c} = \left(\frac{c^{new}}{c^{3\,ex}} \right)^{k}; \; K_{ex}^{4c} = \left(\frac{c^{new}}{c^{4\,ex}} \right)^{k}; \quad (8)$$

4) parameter d:

$$K_{ex}^{1d} = \left(\frac{d^{new}}{d^{1\,ex}} \right)^{k}; \; K_{ex}^{2d} = \left(\frac{d^{new}}{d^{2\,ex}} \right)^{k};$$

$$K_{ex}^{3d} = \left(\frac{d^{new}}{d^{3\,ex}} \right)^{k}; \; K_{ex}^{4d} = \left(\frac{d^{new}}{d^{4\,ex}} \right)^{k}. \quad (9)$$

Taking into account the coefficients determined in this way, the prices of four products are given:

$$P^{1} = P_{ex}^{1} \cdot K_{ex}^{1a} \cdot K_{ex}^{1b} \cdot K_{ex}^{1c} \cdot K_{ex}^{1d}, \quad (10)$$

$$P^{2} = P_{ex}^{2} \cdot K_{ex}^{2a} \cdot K_{ex}^{2b} \cdot K_{ex}^{2c} \cdot K_{ex}^{2d}, \quad (11)$$

$$P^{3} = P_{ex}^{3} \cdot K_{ex}^{3a} \cdot K_{ex}^{3b} \cdot K_{ex}^{3c} \cdot K_{ex}^{3d}, \quad (12)$$

$$P^{4} = P_{ex}^{4} \cdot K_{ex}^{4a} \cdot K_{ex}^{4b} \cdot K_{ex}^{4c} \cdot K_{ex}^{4d}. \quad (13)$$

Then the price of a new industrial property object will be the arithmetic mean of the four above-mentioned prices of analog objects.

However, the proposed refinements for expression (2) can be applied in the case of the formation of the value of such industrial property objects, for which it is possible to find analogues, to pick up similar objects. The disadvantage of the method is that in practice it is rather difficult to find such information.

On the other hand, it is obvious that the base price (P_{bas}) is the price at the breakeven point, that is, equal to the total planned costs for the production of the industrial property object in the period t_p. This assumption is also confirmed by the fact that the final price is formed after the end of the entire production period. That is, it is quite justified to consider it in the corresponding period $P_{bas} = C_t$.

Then, carrying out the corresponding transformations with the expressions (1) and (2), let's obtain:

$$C_e = \left(\sum_{t=t_i}^{t_k} \left(C_t \cdot \frac{\left(S_1 + S_2 \cdot \frac{m_1}{m_0} + S_3 \cdot \frac{o_1}{o_0} + S_4 \cdot \frac{e_1}{e_0} \right)}{100} \right) \cdot \sigma_t \right) \cdot K_a \cdot K_b. \quad (14)$$

Advantages of the proposed method are:

– high level of accuracy of forecasting of economic elements of expenses as a part of the cost price of an industrial property object, which makes possible the use of this method in planning for a long period;

– ability to take into account when planning costs:

a) corrective economic and statistical indicators (inflation indices, etc.) specially designed for such purposes;

b) approved at the national level the value of individual economic elements of costs (minimum wages, fuel and electricity, etc.);

c) other corrective indicators, in particular, cost indicators (net profit, turnover) of the enterprise and indices of the physical volume of products, risk factors, etc.;

d) application of the proposed individual price indices of the enterprise (for materials, raw materials, etc.).

The «bottleneck» of the method is that the specific weight of expenses in the cost structure can also vary in each accounting period, and this requires additional calculations.

In the practice of estimating the cost of innovative pricing technologies, it is considered most effective when cost-effective, profitable and comparative methodological approaches are used together. Knowing, by the costly method, the limits of setting prices for technology, using methods of a comparative approach, it is possible to determine the price permissible on it in the market. For this purpose, it is expedient to apply the method of distribution of 100 points, as a subset of the group of methods of parametric pricing. This method is most often used to adjust the price of products compared to competitors. After all, it allows to accurately assess the competitive position of technologies developed in universities. The prices calculated by this method are more aimed at reflecting the place of technologies developed in universities among competitors, and also provide an opportunity to form a marketing component of the price strategy.

Next to this, to clarify the results of the comparative methodological approach to estimate the cost of technology,

it is advisable to use the method of parametric pricing, in particular, its subspecies – the method of sequential accounting in the price of numerical values of the parameters (5).

As already noted, in the case of transfer to the balance of technologies developed in universities, during the cost estimation, the requirement of applying methods within the cost approach is mandatory. However, when planning the commercialization of technology, the question arises – in which the optimal profit margin from the commercialization of technology will be achieved from the cost-cost-price-calculation options. If rely on the obtained results of cost estimation on the cost approach and apply these results in pricing methods, it is possible to construct such matrix – Fig. 1. he matrix shows the variants of the expected income in one or another of the following methods.

			Pricing methods		
			1. Cost methodical approach («Expenses + % of profit»)	2. Comparative methodical approach based on parametric pricing	3. Comparative methodical approach based on sequential accounting in the price of numerical values of parameters
			P_1	P_2	P_3
Methods of cost estimation formation	1. Cost method («Expenses +»)	C_1	S_{11}	S_{12}	S_{13}
	2. Cost method, taking into account the bonification and the cost of security documents	C_2	S_{21}	S_{22}	S_{23}
	3. Revised cost method, taking into account correction of components of expenses in cost composition	C_3	S_{31}	S_{32}	S_{33}

Fig. 1. Matrix of the ratio of cost estimation, price and profit indicators based on explications of estimation and pricing methods: $S_{11}...S_{33}$ – variants of the expected income in case of application of some explication of cost estimation methods and pricing methods

The profit margin is approximate, since it is determined by the stage of preparing the technology for transfer. However, even such data allow to better assess the commercial attractiveness of the technology.

Let's note the choice of this or that variant of the interrelation of these indicators will give the value of profit, which is expedient to compare with the previously calculated level of break-even technology. The choice of the estimation method, as well as the choice of price, depends on the situation that currently exists in the market, from the specifics of the university and the specifics of the technologies that they generate. The proposed approach to the selection of methods for estimation of technology and their correlation with pricing methods makes it possible to justify management decisions on the implementation of business operations with technologies developed in universities.

7. SWOT analysis of research results

Strengths. Strengths of this method of cost estimation of technology in the cost approach are:

– high level of accuracy of forecasting of economic elements of expenses in structure of the cost price of an object;

– possibility to take into account when planning expenditures:

a) specially designed for such purposes, correcting economic and statistical indicators, as well as approved by the state level of the magnitude of individual economic elements of costs, and other adjustments that are subject to calculation;

b) application of the proposed individual price indicators of the enterprise. This allows to use this method in strategic planning.

Based on the proposed matrix, the ratio of the cost estimation, price and profit indicators based on explications of estimation methods and pricing can justify the technology transfer scenario.

The calculations are carried out with the help of this matrix on the examples of the technologies of the Lviv Polytechnic National University (Ukraine) have shown that accurate estimates can be achieved by applying the specified cost method (14) and pricing methods based on parameter comparisons (Fig. 1, columns 2 and 3).

Weaknesses. Within the specified cost method, the share of costs in the cost of technology can vary in different accounting periods, which will require additional regulation.

The amount of profit obtained on the basis of the use of the author's matrix is the ratio of the estimation indicators, price and profit is approximate and can be used for preliminary calculations.

Opportunities. The specified method of cost estimation of technology within the cost approach is developed taking into account the requirements of the existing regulatory and legal documents, allows to obtain a more accurate estimate of the object. It is important when enrolling technology on the balance of the university.

The proposed methodical explication of cost estimation of technologies with pricing methods is the basis for choosing the scenario for further transfer of these technologies.

Methodical explorations can be used as a tool for deciding whether to start a particular R&D. This approach is the basis for development of other methods of economic estimation of technology.

Threats. The proposed refinements for expression (2) can be applied in the case of the formation of the cost of such technologies for which analogues can be found, which in practice is difficult.

The value of the profit within the matrix ratio of estimation indicators, prices and profits should be compared with the previously calculated level of break-even technology.

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8. Conclusions

1. Refinement of the cost method of assessing the cost of technology is refined. To do this: For this: the expressions for the planning of cost indicators and the application of individual price indices are justified. It is suggested to use indices:

– inflation index reflects depreciation of the national currency;

– individual price index for materials and raw materials of the enterprise;

– index of changes in the value of the minimum wage and, accordingly, of all types of charges on it, and changes in prices for fuel and electricity.

In addition to these, it is possible to apply: indices of value (revenue, turnover) of the enterprise and indices of the physical volume of products. It is also advisable to apply an individual index of the university to determine the change in prices for materials used by it for manufacturing this industrial property object for a certain period of time. The advantage of the refined method is a high level of accuracy in forecasting economic elements of costs in the cost of the industrial property object, making it possible to use this technique in planning for a long period. The disadvantage of the method is that the specific weight of expenses in the cost structure can also vary in each accounting period, which will require additional calculations.

2. To achieve a high level of accuracy in evaluating the competitive positions of technologies developed at universities, the following are proposed:

– methodical explications of cost estimation of technologies (costly methodical approach («Expenses + % of profit»);

– comparative methodical approach based on parametric pricing;

– comparative methodical approach based on the consistent accounting in the price of numerical values of parameters) and pricing methods (cost method («Expenses +»);

– cost method, taking into account the bonification and the cost of security documents;

– specified cost method (taking into account the corrective coefficients of economic elements of costs in the cost structure).

The choice of explication for assessing a significant degree depends on the situation, at the relevant moment it has developed in the market, from the university and the features of the technologies that they generate.

Methodical explications can be used as a tool for deciding the feasibility of initiating certain R&D. The approach is the basis for development of other methods of economic estimation of technology.

3. The matrix of the ratio of the estimation indicators, prices and profits is developed on the basis of the developed methodological explications of estimation and pricing. The matrix is challenged to justify the managerial decisions of the estimated technologies (from the stage of enrolling to the balance of universities to the stage of transfer and dissemination in the market for these technologies). The matrix is a tool to support the technology transfer scenarios.

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