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COMPETITIVE PRICING MODEL FOR R&D PRODUCTS TRANSFER

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The preconditions and modern features of the use of methodical approaches to pricing are considered, as well as the expediency of using the methods of comparative approach, in particular - competitive pricing, in order to form prices for R&D products. Pricing approaches and methods are analyzed for the purposes of concluding agreements on the transfer of R&D products. It is noted that the competitive pricing method used for traditional products does not give correct results in the case of pricing on R&D products. The ratio of possibilities of application of current methodical approaches to pricing with levels of readiness of R&D products is estimated. A model of competitive pricing for R&D products is proposed, which is based on taking into account the indicators of usefulness of R&D products, the cost of their implementation and maintenance. Within these indicators, a number of indices and coefficients are substantiated, which allow to clarify the price of R&D products in a changing competitive environment and adjust the price of R&D products, taking into account its features as an innovative product. To apply competitive pricing on R&D products, a system of equations has been formed, which allows to determine the optimal price of the product in specific terms of the transfer agreement. The author's model was tested on a number of R&D products developed at Lviv Polytechnic National University. The results are substantiated using the universal mathematical editor Mathcad.

Introduction

The spread of the influence of the IVth Industrial Revolution and the popularization of the concepts of the knowledge economy in recent years have led to the need for countries to reconsider approaches to the generation and market launch of R&D products. The relative predictability of the development of innovation processes, characteristic of the world economy a few decades ago (in particular, described by the theories of J. Kitchin, V. Kondratiev, K. Zhuglyar and others) is currently objectively impossible. For example, in the chain "generation of R&D products - convergence of R&D products - generation of new R&D products" the intervals between the emergences of new products were reduced to 2-3 years. This is

happening against the background of globalization and growing competition, marked by the digitalization of the world economy.

According to the statistics of the Ministry of Education and Science of Ukraine [1], during 2014 - 2018, 18,121 agreements on technology transfer were concluded for a total amount of UAH 494.24 million. The largest number of contracts was concluded in 2014, but the largest amount of funds under the concluded contracts was received in 2017 - UAH 144.52 million [1]. However, with the tendency to increase the amount of funds received under technology transfer agreements, there is a simultaneous decrease in the number of concluded agreements, i.e. the average cost of one technology transfer agreement increases: the highest average cost of one such agreement was reached in 2017 - UAH 45.18 thousand, the lowest average cost was noted in 2014 - UAH 12.20 thousand [1]. The imbalance between the generation of R&D products by Ukrainian businesses and the number of transfer agreements indicates a decrease in the level of competitiveness of the technological sector of the country's economy in both the domestic and international arenas.

Insufficient development of interaction of innovatively active business entities on the basis of R&D products transfer in Ukraine is evidenced by the data of the Innovation Index of the European Innovation Scoreboard. Thus, according to this index, low indicators of development of the innovation environment of Ukraine in 2017 are "communications and entrepreneurship" (9.5%), "innovation environment" (4.1%) [2]. Experts [3] note that Ukraine loses the competitiveness of its innovation potential in the final stages of the innovation cycle, where the commercial result from the transfer of R&D products should be ensured.

One of the problematic issues, the unresolved issue of which slows down the transfer, commercialization and effective market launch of R&D products, and, accordingly, the innovative development of the subjects of their transfer, lies in the plane of pricing. Successful competition of innovatively active enterprises in modern markets is impossible without an effective methodological justification of competitive prices for R&D products developed by them. This problem necessitates

the revision of current requirements and approaches to the development of methodological maintenance for competitive pricing for R&D products, which would meet modern market demands.

1. Literary review on the research topic

Unlike pricing on R&D products by cost and revenue approaches, competitive pricing, which belongs to the group of methods of comparative approach, contributes to the most accurate and adequate determination of the place of R&D products on the market, which, accordingly, contributes to the success of transfer agreements. At the same time, effective pricing of R&D products by a competitive method is possible only if the ability of appraisers to gather a variety of different information not only about the R&D product being evaluated, but also its analogues.

At present, the scientific community has developed a significant number of works, which addresses the issue of competitive pricing for R&D products. In particular, some methodological developments for the evaluation of R&D products are proposed in the works of F. Barillas and J. Shanken [4], who consider comparing asset pricing models; Z. Chen and co-authors [5], which substantiate approaches to competitive personalized pricing.

A number of publications of scientists present the author's vision of price formation by competitive methods within certain types of economic activity. For example, D. Vlasic and co-authors [6] suggested competitive pricing in marina business, MA Ülkü and J. Hsuan in [7] proposed competitive pricing of modular products for green consumers, Y.- J. Chen and co-authors [8] competitive pricing strategies in social networks have been studied. Competitive pricing is also studied on the basis of types of interaction of economic entities, which is discussed in particular in the justification of Z. He, T. C. E. Cheng and co-authors [9] evolutionary location and pricing strategies for service merchants in competitive online-to-offline markets.

A number of developments in the field of methodological maintenance for cost

estimation of R&D products were carried out by N. I. Chukhray and scientists in the works [10, 11], P. M. Tsybulev [12], G. A. Androschuk and S. A. Davimuka [13].

Thorough methodological developments based on econometrics are presented in studies by A.N. Sadigh and co-authors [14], where a game theoretical approach to coordination of pricing, advertising, and inventory decisions in a competitive supply chain is proposed, and M. Ghoreishi and scientists [15], who offer joint pricing and replenishment decisions for non-instantaneous deteriorating items with partial backlogging, inflation- and selling price-dependent demand and customer returns.

The basis for the development of methods and models of competitive pricing for R&D products was carried out by us in [16], where we developed a methodical approach to assessing the readiness level of technologies for the transfer, and in [17], where consumer aspects in assessing the suitability of technologies for the transfer. Peculiarities of technical and technological parameters of R&D product, which became the object of approbation of the developed methodology, were investigated in [18].

The analysis showed that the justification of the price of the R&D product when concluding an agreement on its transfer is often seen as a tool for finding a compromise and establishing a partnership in the innovation process.

Most current models of competitive pricing for R&D products are based on the principles of pricing for traditional market goods, and therefore provide for the calculation of the competitiveness index, which takes into account the quantitative or qualitative characteristics and indicators of the price of the object. Since, we consider it incorrect to transfer methodological approaches to the pricing of traditional products to R&D products, as R&D product is a special innovative product, which is evidenced by the following features: embodies the original new knowledge; contains elements of intellectual property; a variety of R&D products is created and provided based on the specifics of industry and market factors; the expected effect of the transfer of R&D products is associated with significant risk, such products can have a significant level of added value and bring profits; time

parameters of R&D products development are much longer, in comparison with a traditional product; the life cycle of R&D products is much shorter than that of traditional products.

From these points of view, it is important to develop a method of competitive pricing for R&D products on the basis of a comparative methodological approach for the purposes of their transfer.

2. Theoretical and methodological principles of competitive pricing for R&D products

The special innovative nature of R&D product requires the transformation of scientific and technical achievements of its developers into a competitive, market advantage with adaptation to the needs of a particular consumer. One of the most important factors in the effectiveness of the commercialization of R&D products is a clear understanding of its nature, types and forms. This is crucial when pricing R&D products and concluding agreements for their transfer to the business environment.

Applying pricing models to traditional products for R&D products will not give an adequate result, as there is a risk of ignoring many important situational factors of the changing market environment. At present, not enough methods and models have been developed to provide a flexible mechanism for competitive pricing of R&D products and to facilitate their effective transfer to the business environment. The lack of such developments causes problems for the subjects of interaction within the transfer agreements, namely: the inability to establish an adequate contract price for R&D products during their transfer to the business environment; complicated consideration of a number of important indicators of R&D products (in particular, in terms of their implementation and development); inefficiency of pricing strategies for R&D products (overestimation of prices for R&D product in some cases, in others - underestimation, which leads to loss of profit); dependence of R&D products projects "on the shelves", etc.

It is advisable to develop a method of competitive pricing within a comparative methodological approach, which would allow you to adjust the price of R&D products, taking into account its features as an innovative product.

To perform this study, the relationship between the possibilities of applying current methodological approaches to pricing with the levels of readiness of R&D products (levels of technological readiness of TRL is based on [16, 17]) (table 1).

Table 1

Correlation of methodological approaches to pricing with levels of technological readiness of R&D products

Methodological approaches	**TRL 1**	**TRL 2**	**TRL 3**	**TRL 4**	**TRL 5**	**TRL 6**	**TRL 7**	**TRL 8**	**TRL 9**
Expensive									
Profitable									
Comparative (market)									
Combined									

The methods of the cost approach are based on the use of indicators of costs incurred by developers to develop an R&D product, so their use can be justified in various forms and at all levels of technological readiness of R&D products. Instead, the methods of the income approach should be used for pricing at above-average levels of readiness R&D product (from TRL 6). Given that revenue methods involve the calculation of expected cash flows (benefits to the consumer), the factors and conditions of use of the R&D product must be justified.

The methods of comparative methodological approach involve comparing data on the technical level of R&D product, so they need thorough information maintenance from the stage of initial evaluation of the effectiveness of the idea and technology (TRL 3). Methods of combined methodological approach to pricing can be applied at different levels of technological readiness of R&D products.

The essence of the competitive method is to determine the market value of R&D products on the basis of selling prices of objects of comparative utility by making adjustments to these prices that take into account the significant differences between analogues and the object of evaluation. One of the priority tasks of using this method is to determine the recommended price range (corridor) for the R&D product. Further adjustment of the price within the specified corridor is the subject of negotiations between the parties to the transfer agreement.

Agreeing on the criteria for selecting the base of comparison is one of the most difficult stages, because the place of origin, financial security, place of sale, and time of sale - these are the factors that significantly affect the value of the transaction and are significantly differentiated. Therefore, their influence in competitive pricing can be taken into account through the justification of the criteria for choosing a comparative base. The approach of P.N. Tsybulev [12] confirms that the determination of the market value of R&D products as objects of industrial property on the basis of existing analogues is possible only with a proper comparison of goals, parameters, scope and conditions of rights, as well as the characteristics of the assessed objects and analog.

3. Substantiation of the competitive pricing method for R&D products transfer

The author's method of competitive pricing for R&D products includes the following stages and sequence of calculations.

The first stage involves determining the price of an R & D product (P1) due to adjusting the price of an analog for the R & D product's utility index:

$$P_1 = P_a \times I_{ut}, \quad (1)$$

where P_a is the price of an analog that is selected for the comparison base, UAH; I_{ut} – utility index, non-dimensional val.

The R&D product is chosen as an analogue, which corresponds to the design solution (designed design) in the field of application and functional purpose and is

widely represented in the selected market. To calculate I_{ut} we use the expression:

$$I_{ut} = I_q \times C_1 \times C_2, \quad (2)$$

where I_q - a comprehensive indicator of quality, non-dimensional val., C_1 - coefficient of innovation R&D product, C_2 - coefficient of environmental friendliness R&D product.

The complex quality indicator (I_q) is determined by comparing the quality indicators of the R&D product and the selected analogue.

A system of indicators of technical level and quality is used to determine I_q. It contains the following groups: indicators of purpose; reliability indicators; safety indicators; indicators of standardization and unification; ergonomic indicators.

The number of indicators to be evaluated will determine the reliability of the results and the level of readiness of the R&D product. The complex quality indicator of R&D product is determined by the method of arithmetic weighted average of the expression:

$$I_q = \sum_{i=1}^{m} C_i \times q_i, \quad (3)$$

where m is the number of unit indicators (parameters) adopted to assess the quality of R&D product, units; q_i - weighting factor of each of the parameters in terms of their impact on the technical level and quality of R&D product (set by experts), while:

$$\sum_{i=1}^{m} q = 1{,}0, \quad (4)$$

where C_i - partial quality indicators determined on the basis of comparison of numerical values of unit indicators of R&D product and analog by expressions:

$$C_i = \frac{P_{pri}}{P_{ai}}, \quad \text{or} \quad C_i = \frac{P_{ai}}{P_{pri}}, \quad (5)$$

where P_{pri}, P_{ai} - quantitative values of the i-th unit quality indicator, respectively, R&D product and analogue.

The coefficient of innovation (C_1) characterizes the level of radical changes in R&D product and allows to determine the degree of change of the basic principles or functional parameters of R&D product relative to the selected analogue. The value of the innovation coefficient is determined according to table 2.

Table 2

The value of the coefficient of R&D product innovation

Level of R&D product	Value
Coincidence with the analogue in most parameters, the level of improving innovation	1.05
The coincidence with the analogue is insignificant, the level of combined innovations	1.1
Significant improvement of basic principles	1.15
Technology solves a new problem or an existing problem in a new way (no analogue)	1.25

The environmental coefficient (C_2) allows to assess the level of change in the impact of R&D product on the environment relative to the analogue - any consequences of using R&D product for the environment, including consequences for the safety of human life and health, flora, fauna, biodiversity, soil, air, water, climate, landscape, natural areas and objects, historical monuments and other material objects or for a combination of these factors, as well as the consequences for cultural heritage sites or socio-economic conditions that are the result of change these factors. The value of the coefficient of environmental friendliness experts choose from table 3.

Table 3

Value of the R & D product's environmental coefficient

Level of impact of R & D product	Value
Worsens	0.6
Slightly worsens	0.85
Does not change	1
Slightly improves	1.1
Improves	1.3

Calculations and pricing of expression (1) should be carried out at the initial and intermediate levels of technological readiness of R&D product.

The second stage of the model involves taking into account in the price of R&D product parameters of the introduction of R&D product from a potential buyer and therefore to determine the price (P_2) the expression:

$$P_2 = \frac{P_a \times I_{ut}}{C_{imp}}, \quad (6)$$

where C_{imp} is the implementation cost index, non-dimensional val.

The implementation cost index is determined by the expression:

$$C_{imp} = \frac{C_3}{C_{impa}/C_{impn}}, \quad (7)$$

where C_3 – the complexity coefficient of implementing R & D product, C_{impa} – the cost of implementing an analog for a potential buyer, UAH, C_{impn} – the cost of implementing R & D product for a potential buyer, UAH. The value of the implementation complexity coefficient is selected from table 4.

Table 4

Value of the R&D product implementation complexity coefficient

The level of impact of R & D product	Value
Complicates	1.02
Makes slightly worse	1.04
Does not change	1
Makes slightly easier	1.02
Makes easier	1.07

Determining the price of an R&D product by expression (6) can be performed at the middle and final levels of readiness of R&D products.

The third stage of the proposed model is the calculation of the price, which is taken as the agreed price for the R&D product (P_3). At this stage, we consider it necessary to take into account an important factor for the development of R&D product - maintenance R&D product, which may include a set of necessary services of a recommendatory nature in the field of staff training, marketing,

technical and technological maintenance and more. It is the presence, conditions and level of maintenance that determines the buyer's decision in today's technology market.

$$P_3 = \frac{P_a \times I_{ut}}{C_{imp} + C_{main}}, \quad (8)$$

$$C_{main} = \frac{C_4}{C_{maina}/c_{mainn}}, \quad (9)$$

where C_{main} – maintenance cost index, non-dimensional val., C_{maina} – costs of analogue maintenance for a potential buyer, UAH, C_{mainn} – costs of R&D product maintenance for a potential buyer, UAH

The maintenance completeness coefficient is selected from the data in table 5.

Table 5

Value of the R & D product tracking completeness coefficient

Feature of R&D product	Value of coefficient
Complete maintenance	1
Partial maintenance	0,5

Then, a competitive method for determining the price of R & D products by forming a number of interrelated price components can be represented as a system of equations:

$$\begin{cases} P_1 = P_a \times I_{ut} \\ P_2 = \dfrac{P_a \times I_{ut}}{C_{imp}} \\ P_3 = \dfrac{P_a \times I_{ut}}{C_{imp} + C_{main}} \end{cases}$$

The developed model of competitive pricing is tested on the examples of R&D products developed at the National University "Lviv Polytechnic". Price calculations for R&D products based on the author's method of competitive pricing were performed using the universal mathematical editor Mathcad. Fig. 1 presents a fragment of such calculations.

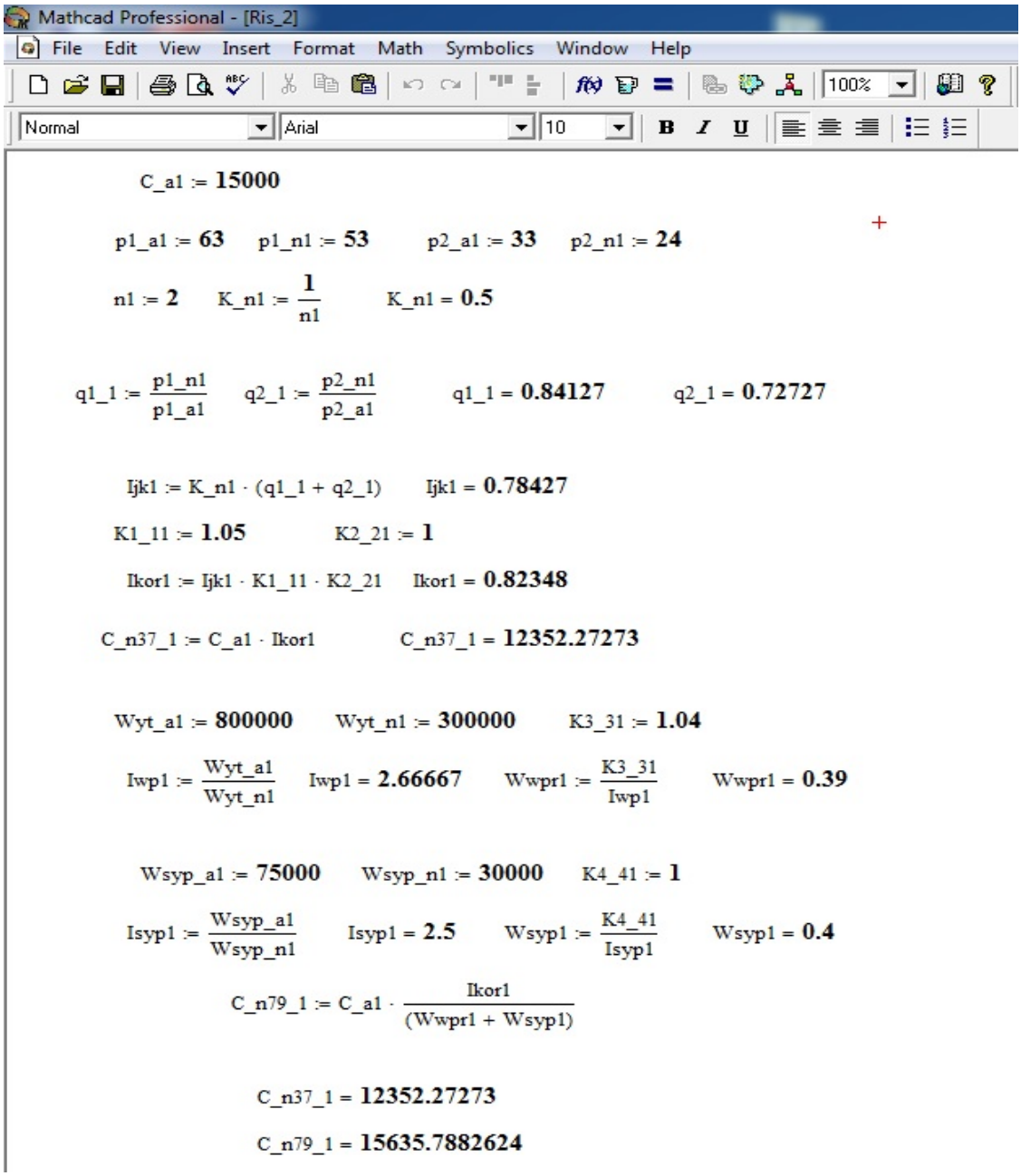

Fig. 1. Calculation of the price for R&D products on the basis of the author's method of competitive pricing using the universal mathematical editor Mathcad (fragment)

Table 6 presents the results of price calculations for R&D products, determined on the basis of the author's method of competitive pricing - C_1, C_2 and C_n.

Table 6

The results of the calculation of prices for R&D products of the National University "Lviv Polytechnic" by the author's method of competitive pricing, UAH.

Names of developments	P_a	P_1	P_2	P_n	$\Delta (P_n - P_a)$
1. Making knives for grinding PET bottles	15000	12352	8886	15635	+635
2. Continuation of the life of machine parts by surfacing under a layer of flux	245	201.68	98.86	106.31	-138.69
3. Restoration of machine elements during modification of the welded roller	245	245.64	95.95	104.08	-140.92
4. Technology of OSL dosimetry means	16700	30728	15708	19434	+2734
5. Mobile robotic platforms: MRP-05 "Borsuk" and MRP-07 "Kubik"	200000	294800	158738	259753	+59753
6. Autonomous system for detection of smoke and leakage of carbon monoxide	5548	6279	3286	3286	-2262
7. Forecasting and Provision of the Given Value of Initial Contact Resistance of the Heterogeneous and Homogeneous and Sections During the Spot Condenser Resistance Micro-Welding	14000	12352	8886	15635	-6466

The results listed in Table 6 are illustrated in fig. 2 (on the example of development No. 1).

Indicators of prices that fell into the shaded in fig. 2 range, can be recommended as a negotiation between sellers and buyers of this R&D product.

For table 6, in the case of a positive value of Δ (options 1, 4 and 5), when the calculated difference between the price of the evaluated R&D product and the price of the analogue is positive, negotiations at the conclusion of the agreement may be conducted to reduce the transaction price. In cases of negative value of Δ (options 2, 3, 6 and 7), developers need to review the terms of the agreement to increase the usefulness of the development, improve the conditions for providing a support package. Such measures should increase the competitive attractiveness of the R&D product in relation to the selected analogue and transfer conditions.

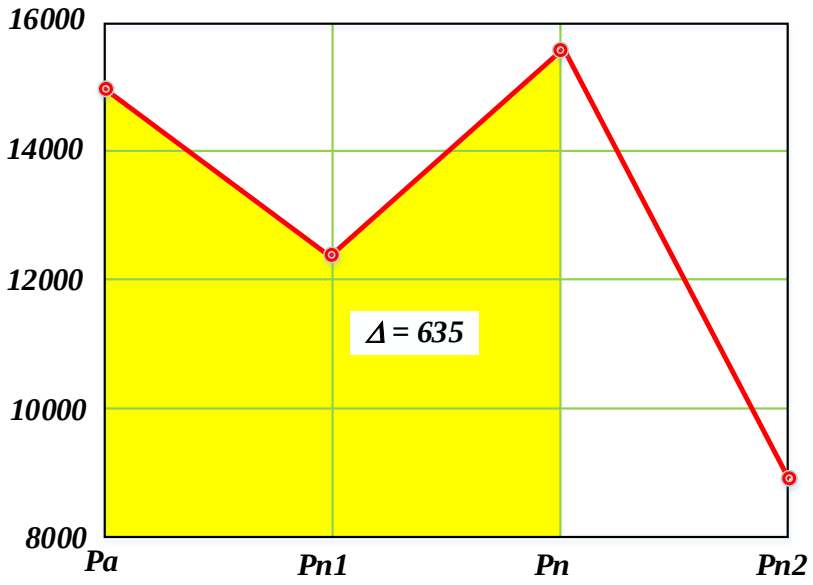

Fig. 2. Price chart for R&D product "Manufacture of knives for grinding PET bottles"

Conclusions

The competitive method of pricing occupies a special place in the system of methods of comparative approach. This method allows the most comprehensive and systematic consideration of a set of factors that, on the one hand, form the internal attractiveness of R&D products for customers by assessing the usefulness and cost of implementation, and on the other, take into account the real conditions of the competitive environment.

Indicators of internal attractiveness of R&D products as a result of the innovation process should take into account, in addition to indicators of technical level and quality level, also indicators of innovation, environmental impact on the environment. Due to the growing complexity and technological excellence of modern R&D products, when determining the purchase price, it is necessary to take into account the complexity of development and costs of the buyer when implementing R&D product in the business model of the entity. The process of implementing an R&D product can be significantly affected by the package of support services provided by the developer or specialized organizations.

In the considered model of specific pricing it is expedient to continue research taking into account branch differences which affect indicators of innovation of R&D product and identification of a direction and force of influence of a brand of the developer of R&D product as the share of cost of a brand is considerable in cost of R&D product.

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