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EVALUATION OF DIFFUSION OF HIGH-TECH PRODUCTS: MORPHOLOGICAL ANALYSIS

ОЦІНЮВАННЯ ДИФУЗІЇ ВИСОКОТЕХНОЛОГІЧНОЇ ПРОДУКЦІЇ: МОРФОЛОГІЧНИЙ АНАЛІЗ

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Introduction. *The urgency of scientific research is confirmed by the fact that under the conditions of globalization, reform of the national economy, as well as strengthening of integration processes, the level of competitiveness of industrial enterprises is determined by many factors, with innovative activity being the key one. It is thanks to innovations that the business entity has the ability to strengthen its market positions, improve its economic efficiency, and create higher added value. A necessary condition for ensuring a certain level of efficiency of innovation is the dissemination of the results of these activities to the consumer, not just their creation. This purpose can be achieved through the diffusion of innovation results of industrial enterprises.*

The purpose of paper *is to improve the method of diffusion identification during the commercialization of high-tech products of industrial enterprises using morphological analysis.*

Results. *Based on the results of studying the comparative characteristics of alternative methods of assessing the impact of diffusion on the efficiency of commercialization of high-tech products, the authors proved the feasibility of using morphological analysis tools to solve the problem, setting targets, analysis of variants of possible change of parameters of nodal points of object of estimation. To the list of nodal points, in this case, the authors include the volume and the speed of sales of high-tech products, the number of sources of its distribution, as well as the saturation of the market with these products. The parameterization of diffusion characteristics during the commercialization of high-tech products of industrial enterprises is proposed by calculating the market capacity of high-tech products, the indicator of speed (turnover) of its implementation, the coefficient of diversification of sources of distribution of these products in the market, as well as calculating the increments of the corresponding coefficients.*

Conclusion. *The method of diffusion identification during commercialization of high-tech products of industrial enterprises has been improved, which takes into account the tools of morphological analysis and allows commercialization project managers to synthesize factor and result features of diffusion and also allows to establish causal relationships between factor and result features of such diffusion.*

* * *

Вступ. *В умовах глобалізації, реформування національної економіки, а також посилення інтеграційних процесів рівень конкурентоспроможності промислових підприємств визначається багатьма чинниками, ключовим із яких є інноваційна активність. Саме завдяки інноваціям суб'єкт господарювання має змогу посилювати свої ринкові позиції, покращувати показники економічної ефективності, а також створювати більшу додану вартість. Необхідною умовою забезпечення визначеного рівня ефективності інноваційної діяльності є поширення результатів цієї діяльності до споживача, а не тільки їх створення. Цієї мети можна досягнути за допомогою дифузії результатів інноваційної діяльності промислових підприємств.*

Метою *дослідження є удосконалення методу ідентифікування дифузії під час комерціалізації високотехнологічної продукції промислових підприємств.*

Результати. *У статті за результатами вивчення порівняльних характеристик альтернативних методів оцінювання впливу дифузії на ефективність комерціалізації високотехнологічної продукції авторами доведено доцільність використання для вирішення окресленого завдання інструментарію морфологічного аналізу, який передбачає встановлення цілей, встановлення вузлових точок, які характеризують комерціалізацію, ідентифікування варіативності в межах кожної вузлової точки, а також аналізування варіантів можливої зміни параметрів вузлових точок об'єкта оцінювання. До переліку вузлових точок, за цих обставин, авторами віднесено обсяг і швидкість реалізації високотехнологічної продукції, кількість джерел її поширення, а також насиченість ринку цією продукцією. Параметризацію характеристик дифузії під час комерціалізації високотехнологічної продукції промислових підприємств у роботі запропоновано здійснювати шляхом обчислення коефіцієнта*

місткості ринку високотехнологічної продукції, показника швидкості (оборотності) її реалізації, коефіцієнта диверсифікації джерел поширення цієї продукції на ринку, а також обчислення під час росту відповідних коефіцієнтів.

Висновки. *Вдосконалено метод ідентифікування дифузії під час комерціалізації високотехнологічної продукції промислових підприємств, що враховує інструментарій морфологічного аналізу й уможливлює для керівників проєктів комерціалізації синтезування факторних та результативних ознак явища дифузії, а також дає змогу встановлювати причинно-наслідкові зв'язки між факторними та результативними ознаками такої дифузії у розрізі кожної вузлової точки й кожного варіанту зміни її параметрів, що знижує рівень суб'єктивізму управління процесами комерціалізації.*

Keywords: *diffusion evaluation, high-tech products, morphological analysis, decomposition, enterprise, identification*

Ключові слова: *оцінювання дифузії, високотехнологічна продукція, морфологічний аналіз, декомпозиція, підприємство, ідентифікування*

INTRODUCTION

There is a phenomenon of diffusion during the commercialization of high-tech products. The diffusion of high-tech products can, to some extent, be a manageable and predictable phenomenon. Such diffusion occurs when innovations are spread in the market through licensing, franchising, leasing [1]. Despite this, innovators often lose control of diffusion, resulting in random, disordered movement of high-tech products. An uncontrolled diffusion occurs when unlicensed copies of high-tech products or any of their counterparts appear in a particular market in a certain period of time.

The process of commercialization of high-tech products is more effective, the longer the period of controlled diffusion lasts. It is worth recognizing that an innovator can implement measures to maximize the duration of controlled diffusion, however, it is obvious that the probability of unlicensed copies of high-tech products and their analogues can not be reduced to zero.

Taking into account that diffusion affects the efficiency of commercialization of high-tech products, it must be evaluated. This need is due to the need to justify decisions aimed at ensuring the effectiveness of commercialization of high-tech products of economic entities.

In the scientific literature, the issue of diffusion of innovations is covered in the works E. Rodzhera, N. Chuhrai, L. Vankovycha, H. Shamota. Works in which the issue of identification of diffusion of high-tech products is covered at the same time is not much.

The **PURPOSE** of the paper is to improve the method of diffusion identification during the commercialization of high-tech products of industrial enterprises using morphological analysis.

RESEARCH METHODS

The following methods were used in research: comparative, morphological analysis, system analysis.

RESULTS

The purpose of morphological analysis is to qualitative and quantitative assessment of diffusion of high-tech products on the basis of establishing causal relationships between the factors that caused the phenomenon of diffusion and options for enabling the management of this phenomenon.

This type of analysis involves such decomposition of the object under study, which would allow, based on the establishment of its essential features to identify causal relationships between factor and performance features that characterize it from the standpoint of a particular state.

The conducted studies suggest that alternatives of morphological analysis are discriminant and cluster analysis, including isomorphic and isotopic, functional-cost analysis, analysis by the method of constructing network graphs, as well as analysis by constructing a cognitive map, in particular the Petri net. The common basis of these alternatives is that they are all based on the method of focal objects, it means that these types of analysis focus on objects that have common features.

Focusing on features that are common to objects is possible when there is a separation of the set of studied objects into a certain holistic phenomenon. This task is the result of formalization as the highest level of abstraction. Common to the selected types of analysis is also that they involve the division of the studied phenomenon into relatively independent parts, and the establishment of certain relationships between them. The use of morphological analysis to assess the impact of diffusion on the efficiency of commercialization of high-tech products has a number of convincing advantages over other alternative types of analysis.

Decomposition as a cross-cutting tool of morphological analysis requires the selection of so-called nodal points that characterize the phenomenon of diffusion of high-tech products. Generalization of the review of literature sources [2–4] and study of materials of industrial enterprises (PJSC "NGK Industrial Systems", PJSC "Plant Equator", LLC HC "MICRON", SE Orizon-Navigation", PJSC "Transformer Plant", PJSC "Sumykhimprom", PJSC" Meridian named after SP Korolyov", PJSC "Korosten MDF Plant", SE "Plant Arsenal", PJSC "Kyiv Radio Plant") allow to state that such key points are: the volume and the speed of sales of high-tech products; the number of sources of distribution of high-tech products; the market saturation with high-tech products [5].

For the practical application of these diffusion characteristics, they must be parameterized by:

1) the calculation of the coefficient of market capacity of high-tech products:

$$k_1 = \frac{O_r}{M_r} \cdot 100\%, \quad (1)$$

where k_1 – the coefficient of market capacity of high-tech products, %;

O_r – the sales volume of high-tech products, pieces;

M_r – the market capacity of high-tech products, pieces.

2) the calculation of the rate (turnover) of sales of high-tech products:

$$k_2 = \frac{360}{O_{r_r} / O_a}, \quad (2)$$

where k_2 – the indicator of speed (turnover) of sales of high-tech products, days;

O_{r_r} – the annual sales of high-tech products, thousand UAH;

O_a – the average annual value of working capital of the enterprise, thousand UAH;

3) the calculation of the coefficient of diversification of sources of distribution of high-tech products on the market:

$$k_3 = \frac{K_d}{K_s} \cdot 100\%, \quad (3)$$

where k_3 – the coefficient of diversification of sources of distribution of high-tech products on the market,%;

K_d – the number of organizations that sell high-tech products on the market, units;

K_s – the number of organizations that could sell high-tech products on the market, units;

4) the calculation of the growth rate of the market capacity of high-tech products:

$$\Delta_1 = k_{1_z} - k_{1_b}, \quad (4)$$

where Δ_1 – increase in the coefficient of market capacity of high-tech products, %;

k_{1_z} – the value of the market capacity ratio of high-tech products in the reporting period, %;

k_{1_b} – the value of the market capacity factor of high-tech products in the base period, %;

5) the calculation of the growth rate of (turnover) of sales of high-tech products:

$$\Delta_2 = k_{2_z} - k_{2_b}, \quad (5)$$

where Δ_2 – increase in the rate of the speed (turnover) of high-tech products, days;

k_{2_z} – the value of the rate of (turnover) of sales of high-tech products in the reporting period, days;

k_{2_b} – the value of the rate of (turnover) of sales of high-tech products in the base period, days;

6) the calculation of the growth rate of diversification of sources of distribution of high-tech products on the market:

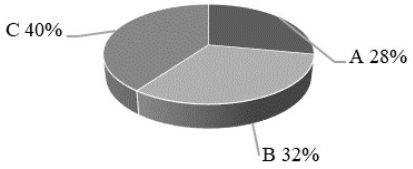
$$\Delta_3 = k_{3_z} - k_{3_b}, \quad (6)$$

where Δ_3 – the increase in the coefficient of diversification of sources of distribution of high-tech products on the market,%;

k_{3_z} – the value of the coefficient of diversification of sources of distribution of high-tech products on the market in the reporting period, %;

k_{3_b} – the value of the coefficient of diversification of sources of distribution of high-tech products on the market in the base period, %.

In order to establish the relative importance of the parameters that characterize the diffusion of high-tech products of the enterprise, an expert study was conducted among the heads of enterprises that are manufacturers of high-tech products (Fig. 1).



Symbols: A – the value of the coefficient of relative importance Δ_2; B – is the value of the coefficient of relative importance Δ_3; C – is the value of the coefficient of relative importance Δ_1

Fig. 1. Coefficients of relative importance of parameters that characterize the diffusion of high-tech products of the enterprise [It was built by the authors based on the results of expert research]

According to the results of the above, it was found that among the identified parameters, the most significant impact on the efficiency of the process of commercialization of high-tech products has an increase in the market capacity ratio.

The value of its coefficient of relative importance is 40%. In the second place was the increase in the coefficient of diversification of sources of distribution of high-tech products on the market. The value of its coefficient of relative importance is 32%.

In turn, the increase in the rate of sales of high-tech products, as it turned out, has the lowest coefficient of relative importance in terms of influencing the efficiency of the process of commercialization of high-tech products. Its value is 28%.

Identifying the variability of the parameters of the nodal points that characterize the diffusion of high-tech products of the enterprise is essentially a set of unary operations, it means the operations with only one operand (operand – a structure that specifies the value of the argument of the operation). In this case, unary operations are realized within operands Δ_1, Δ_2, Δ_3. From the position of Boolean algebra for each of them the following identities are characteristic:

$$1 \wedge 1 = 1 \wedge 0 = 0 \wedge 1 = 1; \quad 0 \vee 0 = 0 \vee 1 = 1 \vee 0 = 0. \quad (7)$$

Within each operand, there is a conditional disjunction (a logical operation, which is mostly used as a way to construct branches (vectors) of dendrites in algorithms). Formally, it can be written as follows (the judgment indicates that when Y, then X, otherwise Z):

$$\{X, Y, Z\} \leftrightarrow \{Y \to X\} \wedge (\neg Y \to Z), \quad (8)$$

where X – is the positive increment of the operand;

Y – negative increment of the operand;

Z – is the absence of operand increments.

Based on this, we construct a truth table for conditional disjunction (Table 1).

It is worth noting that regardless of the fact that the selected operands are a set that characterizes the diffusion of high-tech products of the enterprise as a whole phenomenon (Fig. 2), there is no place for ternary conditional operation, because such an operation involves the dependence of the second and third operands given by the first operand.

If such a dependence existed, then the diffusion of high-tech products could be judged only by those parameters that acquire the value of 1 (Table 2).

Guided by the above provisions, we can identify options for the parameters of the nodal points, which characterize the diffusion of high-tech products of the enterprise and set their quality gradation (Table 3).

Table 1

Truth table for conditional disjunction during diffusion of high-tech products * *[on the basis [6;7]]*

Positive increase in the operand, X	Negative increase of the operand, Y	Absence of the growth of operand, Z	(X, Y, Z)
1	1	1	1
1	1	0	1
1	0	1	1
1	0	0	0
0	1	1	0
0	1	0	0
0	1	1	1
0	0	0	0

**Symbols: 1 - yes, 0 - no.*

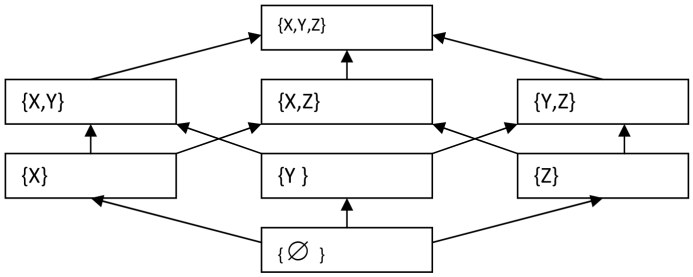


Fig. 2. Dependencies between subsets of the set X, Y, Z [on the basis [6 – 9]]

Table 2

The results of ternary addition modulo 2 [*it was built by the authors on the basis of [6 – 9]*]

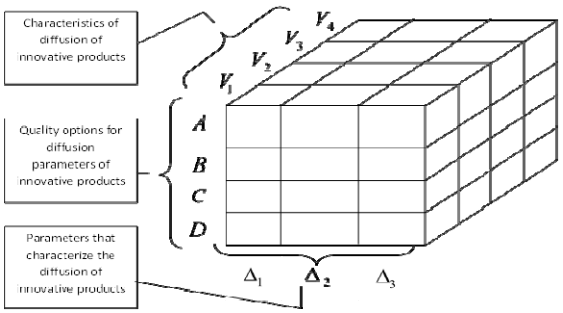
X	Y	Z	⊕	(X, Y, Z)
0	0	0		0
1	0	0		1
0	1	0		1
1	1	0		0
0	0	1		1
1	0	1		0
0	1	1		0
1	1	1		1

Table 3

The variability of parameters of nodal points, which characterize the diffusion of high-tech products of the enterprise [*it was created by the authors*]

Version	Parameters			Gradation of quality options
	Δ_1	Δ_2	Δ_3	
1	1	1	1	Very high
2	1	1	0	High
3	1	0	1	
4	0	1	1	
5	0	0	1	Low
6	0	1	0	
7	1	0	0	
8	0	0	0	Very low

The next step in evaluating the diffusion of high-tech products based on the application of morphological analysis is to identify options for possible changes in the parameters of the nodal points that characterize the object of evaluation. Execution of this task is based on the construction of the cube of F. Zwicky (Fig. 3).



Symbols: V1 – the sales of high-tech products; V2 – the speed of sales of high-tech products; V3 – the sources of distribution of high-tech products; V4 – the saturation of the market of high-tech products

Fig. 3. Parameters for evaluating the diffusion of innovative products

Thanks to him it is possible to establish causal relationships between the factorial and the performance characteristics of the object of evaluation in the context of each node and each option to change its parameters. According to the results of establishing the growth of nodal points that characterize the diffusion of high-tech products of the enterprise, the quality of the detected changes is identified.

After that, the identification of the relative importance of the parameters that characterize the diffusion of high-tech products is provided. Despite the fact that as a result of expert research such importance has been established, it should be recognized that it may vary depending on such factors as the level of intellectual capacity of high-tech products, the level of technological complexity of high-tech products, high-tech products belonging to mass, serial or unit production the level of protection of high-tech products by patents, etc. [10]. Establishing the relative importance of the parameters is the basis for the conclusion about the presence of the phenomenon of diffusion of high-tech products and its quality, and the identification of reserves to improve the results of commercialization of high-tech products.

CONCLUSION

Studies have shown that the generalization of the source information of morphological analysis, which forms the basis for identifying reserves to improve the results of commercialization of high-tech products, it is advisable to carry out on the basis of so-called morphological analysis

The Morphological analysis of the diffusion phenomenon of high-tech products is a decomposition process of isolating the essential characteristics of diffusion in order to establish cause-and-effect relationships between the factors that caused the diffusion phenomenon. The diffusion is inextricably linked to the efficiency of commercialization of high-tech products, so it is important to synthesize the initial data obtained from morphological analysis to identify reserves to increase the efficiency of commercialization of innovations. The synthesis involves the dissociation of disparate multi-vector information into one whole thing, it means if the analysis builds a tree-like structure in the shape of a dendrite, then during morphological synthesis the dendrite is a set of vectors that indicate how to improve the commercialization of high-tech products.

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