

FUZZY MODEL FOR SWOT-ANALYSIS OF PHARMACEUTICAL ENTERPRISE'S FUNCTIONING

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Application of the approach on the basis of fuzzy sets for carrying out the SWOT-analysis of industrial commercial activity, position and prospects in the competitive market for the pharmaceutical enterprises has been described. The method is based on receipt and processing of soft expert's estimations of strengths and weaknesses of the pharmaceutical enterprises' functioning. These estimations also consider potential opportunities and threats of commercial activity in a market under competitive and crisis conditions. The technique of practical fuzzy modeling has been developed. The corresponding computer model in Fuzicalc has been constructed. The example of numerical calculations has been given. The interpretation technique for the obtained results of modeling and further obtaining of accurate generalized estimations of conditions and development prospects of the pharmaceutical enterprises and firms functioning has been offered.

Key words: fuzzy sets, fuzzy modeling, SWOT-analysis, drugs distribution, information systems in pharmacy, pharmaceutical market, pharmaceutical enterprises.

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ФАЗИ МОДЕЛЬ SWOT-АНАЛІЗУ ФУНКЦІОНУВАННЯ ФАРМАЦЕВТИЧНОГО ПІДПРИЄМСТВА

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Описано застосування підходу, що базується на використанні теорії нечітких множин, для проведення SWOT-аналізу виробничо-комерційної діяльності фармацевтичних підприємств, аналізу їх положення й перспектив існування в конкурентному ринковому середовищі. Запропоновано модель, що передбачає отримання й представлення в нечіткій формі та подальшу відповідну обробку експертних оцінок сильних і слабких сторін функціонування фармацевтичних підприємств. Також одночасно розглянуто оцінки потенційних можливостей і загроз для підприємства в процесі комерційної діяльності на ринку в умовах конкуренції та кризи. Розроблено методику практичного застосування нечіткого моделювання для цих цілей. Побудовано відповідну комп'ютерну модель у середовищі спеціалізованого програмного забезпечення Fuzicalc. Наведено приклад числових розрахунків у нечітко-множинній постановці та їх результати. Подано інтерпретацію отриманих результатів моделювання та подальшої побудови чітких узагальнених оцінок стану та перспектив розвитку фармацевтичного підприємства.

Ключові слова: нечіткі множини, нечітке моделювання, SWOT-аналіз, дистрибуція лікарських засобів, фармацевтичний ринок, фармацевтичні підприємства, інформаційні системи у фармації.

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ФАЗЗИ МОДЕЛЬ SWOT-АНАЛИЗА ФУНКЦИОНИРОВАНИЯ ФАРМАЦЕВТИЧЕСКОГО ПРЕДПРИЯТИЯ

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Описано применение подхода, основывающегося на использовании теории нечетких множеств, для проведения SWOT-анализа производственно-коммерческой деятельности фармацевтических предприятий, анализа их положения и перспектив существования в конкурентной рыночной среде. Предложена модель, предусматривающая представление в нечеткой форме и последующую соответствующую обработку экспертных оценок сильных и слабых сторон функционирования фармацевтических предприятий. Также одновременно рассмотрены оценки потенциальных возможностей и угроз для предприятия в процессе коммерческой деятельности на рынке в условиях конкуренции и кризиса. Разработана методика практического применения нечеткого моделирования для этих целей. Построена соответствующая компьютерная модель в среде специализированного программного обеспечения Fuzicalc. Приведен пример численных расчетов в нечетко-множественной постановке и их результаты. Представлена интерпретация полученных результатов моделирования и последующего получения четких обобщенных оценок состояния и перспектив развития фармацевтического предприятия.

Ключевые слова: нечеткие множества, нечеткое моделирование, SWOT-анализ, дистрибуция лекарственных средств, фармацевтический рынок, фармацевтические предприятия, информационные системы в фармации.

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It is obvious that in modern conditions, mathematical and computer modeling of industrial-commercial component's activity of the pharmaceutical enterprises (as well as the interaction processes for subjects of pharmaceutical products and medical goods distribution purposes) is the important management tool for the pharmaceutical enterprises [1].

Computer modelling is applied in a pharmaceutical firm's management of the proved administrative decisions, which are directed at strengthening the enterprise's position in the competitive pharmaceutical market, and on the solution of the important public and social problems of the population's maintenance improvement with the help of pharmaceutical and medical products [2; 3].

Review of the literature on computer modeling of business processes has shown the following.

One of the well-known and widespread modelling methods of this kind is the SWOT-analysis (Strength, Weakness, Opportunity, Threat – analysis) [4; 5]. The significant amount of research works and publications are devoted to application of the SWOT-analysis to studying the pharmaceutical enterprise's work and business activity. Thus we have considered the industrial pharmaceutical enterprises and wholesale pharmaceutical firms, as well as pharmacies (drugstores) [1; 6].

It should be emphasized that, in general,

SWOT-analysis has been widely and successfully applied to the analysis of business processes in various sectors of the economy [7; 8].

It is used to study the situation in a competitive market and opportunities for enterprises of different ownership forms in a variety of socio-economic conditions. Specific parameters (criteria) of such analysis are also different.

This is determined by the investigator in each case depending on the industry, size and location of the enterprise, the nature of its activities and so on.

However, the traditional approach to the use of SWOT analysis (and the corresponding formulation of the problem) has a number of common features.

They limit its adequate using and are sufficient to obtain reliable results in the conditions, in fact existing under competitive market environment uncertainty conditions.

The main one is that in all analyzed cases, in all these works the technique of the SWOT-analysis is applied in classical, well known formulation.

In case of classical formulation, the authentic, proved results and the account of pharmaceutical branch's specificity are provided due to correct definition and selection of components, parameters for the analysis, as well as careful search, accumulation, processing great amounts of statistical information [9 – 14].

However, in competitive market conditions, receipt of such information is not always possible. Sometimes,

considering a significant amount of the material, time and human resources (needed for its collecting and processing), it is economically inexpedient and unjustified.

Besides, the significant part of such information due to the origin mechanism cannot be exact, absolute and precise. This information contains and reflects various uncertainty and illegibility, which is generated by direct sources of information (interrogation of experts, auditors, population etc.), environments and various external factors (the market situation, condition of the economy and the population, forecasts and so forth).

Thus, there is a new scientific problem, which can be formulated as follows. It is necessary to develop and offer a new model of SWOT-analysis.

The model should be able to take into account uncertainties of various origins and have the necessary theoretical and mathematical basis.

Finally, the model should be realizable using appropriate information technologies and modern computer simulation tools.

It is the main purpose of our study as well as the article.

Accordingly, the aim of the research is to develop the fuzzy approach and corresponding indistinct plural model for the SWOT-analysis of a pharmaceutical enterprise, which gives an opportunity to account illegibility in entrance data estimations to analyse influences of various business factors.

Also the study of methodical approaches to compare the final modelling results for total negative and positive estimation summaries of the enterprise's activity components has also been provided.

And, as finally, the substantiation of an opportunity of development for incorporated conclusions concerning

pharmaceutical firm's position and prospects.

At the first investigation phase, via expert interrogation of heads, leading specialists, managers of some industrial and wholesale pharmaceutical enterprises in Kharkiv (Ukraine), mark estimations of strengths and weaknesses, opportunities and threats for their enterprises were received. These were the necessary input data for the next step – fuzzy SWOT-analysis calculation.

The list and values of the corresponding criteria are given in Table.

Thus, direct estimations of components were given by each separate interrogated expert in borders from 1 up to 4 points and competences of experts were estimated from 1 up to 5 points.

Total general estimations have been received by averaging, in the view of experts competence, on the algorithm resulting from the previous papers of the authors.

The final estimation for each of the four criteria making SWOT-analysis has been calculated as the sum of multiplying corresponding parameter estimations from separate experts by their rank, divided by the quantity of experts.

Such approach is standard, well-known, and widely applied to receive generalized estimations.

One of the features of the given research was that the experts were offered to determine not only ball estimations, but also to define approximate intervals of their fluctuation. It has enabled to establish fuzzy borders for the estimations.

This is the true way to consider and analyze the uncertainty, which is always inherent in estimations of everyone concretely and separately interrogated.

Table

Mark estimations of the SWOT-analysis components for the pharmaceutical enterprises

Parameter of estimation		general point	Parameter of estimation		general point
Strengths	1. Reliable marketing network	16,2	Weaknesses	13. Low share in the market	12,6
	2. Increase in working capital	9,8		14. Lack of advertising policy	11,8
	3. Sufficient popularity	14,0		15. Average level of the prices	12,2
	4. Wide assortment of output	17,6		16. Low level of marketing control	13,8
	5. High quality assurance	16,2		17. Deficiency of marketing experts	13,4
	6. High motivation of the personnel	8,6		18. Growth of inflation	7,8
	7. Presence of exclusive drugs	11,2		19. Strengthening of competition	15,8
Opportunities	8. Change in advertising technologies	9,4	Threats	20. Decrease in standards of living	5,6
	9. Reduction of prices on raw materials	10,6		21. Fluctuations of exchange rate	6,2
	10. Occurrence of new suppliers	12,4		22. Change in consumer preferences	9,8
	11. Development of information technologies	12,8		23. Occurrence of similar drugs	12,0
	12. Increase in market share	14,2			

Further for each separate estimation parameter, the kind of membership functions has been certain: triangular (when the intervals of fluctuation specified by experts, have appeared relative) and trapezoid (when the specified intervals essentially differed).

Thus, membership functions for each model parameter were constructed. Corresponding graphic view is shown in Fig. 1 (input estimations) and Fig. 2 (summary results for each of the four SWOT-components).

Parameters presented in the initial data table (Table) have the same numbers in Fig. 1.

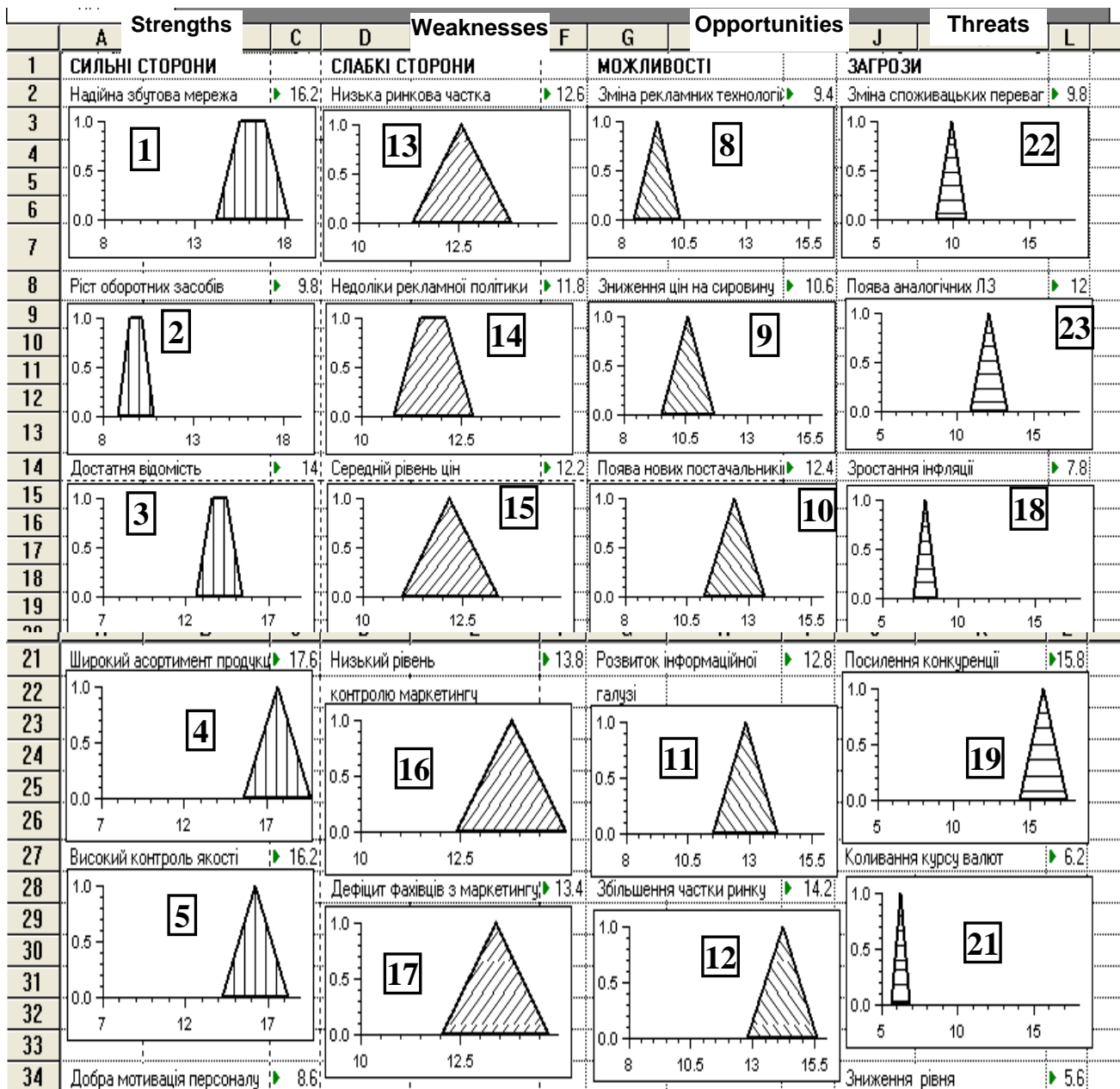


Fig. 1. Graphic representation for separate input parameters of the fuzzy SWOT-analysis

Having associated separate components, we have obtained final estimations of strengths (13,55), weaknesses (12,81), opportunities (12,02) and threats (10,97) for the pharmaceutical enterprise, which was considered.

On the basis of the expert interrogation results (given above) the computer model in the Fuzicalc tool of modeling has been created.

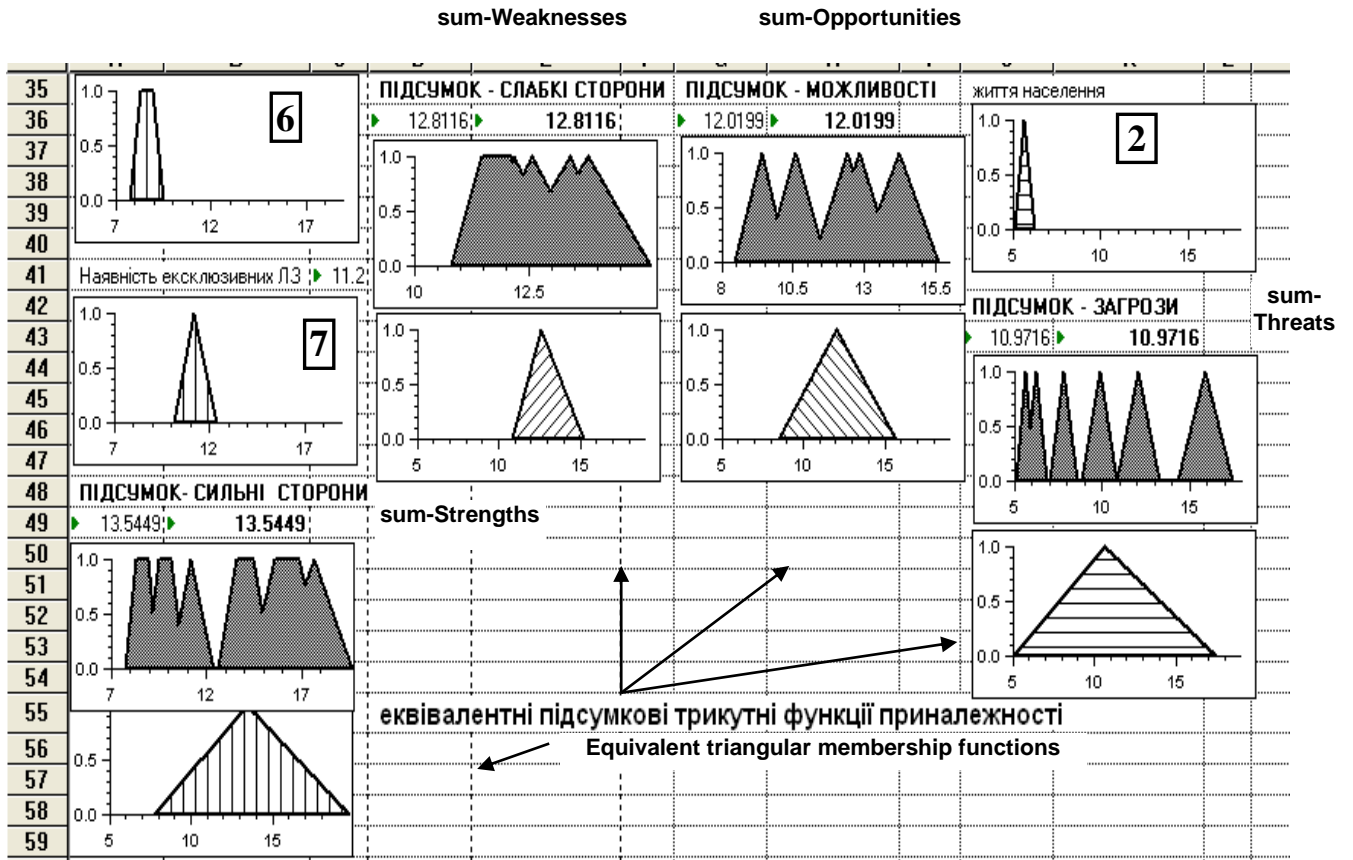


Fig. 2. Graphic representation of summary results for each of four SWOT-components

Further, the calculations of optimistic and pessimistic variants for pharmaceutical firm in indistinct market environment have been made.

The presented (see Fig. 2) equivalent triangular membership functions have the same area and average value, as well as actual functions on the basis of it's summary.

Thus their width displays a degree of uncertainty of results, i. e. expectancy and opportunities of deviation from average values.

For the final estimation of the condition at the enterprise on the basis of the chosen parameters it is expedient to compare the incorporated strengths and opportunities on the one hand, and both the incorporated weaknesses and threats – on the other.

The results of the comparison are presented in Fig. 3

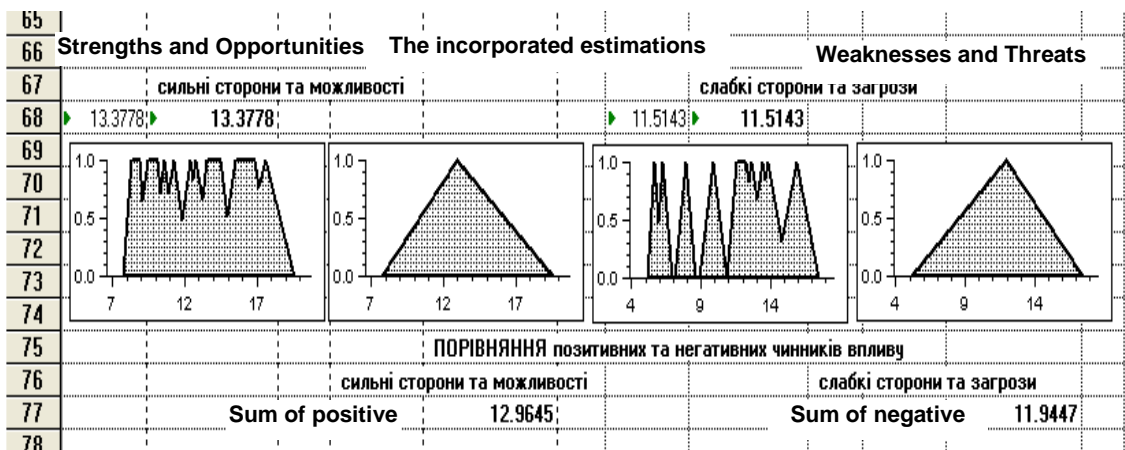


Fig. 3. Final results of the fuzzy SWOT-analysis

In this case (see Fig. 3) positive components (estimated at 12,96) prevail negative factors (estimated at 11,94), which testifies to the presence of insignificant (but with tendencies favorable for the enterprise) conditions of internal and external business environment.

The developed computer model allows to estimate operatively results of change in separate factors, their influence on the final results of the fuzzy SWOT-analysis for pharmaceutical enterprises. It can also be applied to the comparison and definition of prospects of commercial-industrial activity for several pharmaceutical enterprises, middle and short-term forecast and so forth.

It also allows regular monitoring of a pharmaceutical firm's market position and its opportunities to change a competitive business environment. It enables making necessary management decisions for the improvement of commercial position and increase in competitiveness of drug producers, drug-distributors, wholesalers and pharmacies in the pharmaceutical market.

The offered approach can be used to research the condition of various enterprises of the pharmaceutical branch – manufacturers of medicines, wholesale firms-intermediaries, other suppliers, retail chemists institutions, as well as enterprises, firms and organizations of other branches of the economy.

Thus, the model for realization of the fuzzy SWOT-analysis of pharmaceutical enterprises industrial-commercial activity (on the basis of uncertain expert' estimations of strengths and weaknesses, opportunities and threats, which are available, presented and operate in market competitive conditions) has been developed.

The practical analysis technique and the way of modeling results interpretation have also been offered. In particular, final estimations for pharmaceutical enterprise's position in the market and prospects of its functioning, obtained on the basis of fuzzy SWOT-analysis have been described.

Principles, approaches and features of computer modeling and techniques of practical calculations with the use of computer means in processing fuzzy numbers and functions in the environment Fuzicalc have been investigated.

The results of the corresponding calculations for one of the pharmaceutical firms of Kharkiv Region (Ukraine) have been presented and analyzed.

The directions of the subsequent research are to develop the methodology of fuzzy SWOT-analysis modeling in order to improve position and functioning of the pharmaceutical enterprises in difficult conditions of the drug market.

Thus, the results of studies, which have been conducted and presented in this paper, enable us to make the following conclusions. Firstly, formulation and solution of the described SWOT-analysis problem in a fuzzy logic setting have been presented, validated and implemented with the use of specialized software,. It allows to receive adequate and informative simulation results, which reflect the real state of the pharmaceutical company and its potential.

Moreover, the proposed approach is quite general by nature. It can be successfully applied not only to analyze functioning of enterprises and organizations of the pharmaceutical profile, but also for other subjects of business, operating under market conditions.

It is possible and necessary to further develop the presented approach in the directions of constructing and using a more complex form for membership functions for a more accurate simulation of the considered parameters of fuzzy SWOT-analysis in practical terms.

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