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MODELING THE ADVERTISING STRATEGY OF ENTERPRISES ON THE PHARMACEUTICAL PRODUCTS MARKET

Abstract. *An analysis of the studies results on the advertising strategies formation for industrial enterprises is carried out. The specifics of the advertising strategies development by pharmaceutical industry enterprises are determined. A review of well-known applications of the mathematical apparatus during the problem solution is explored. The necessity of using the simulation approach in the process of modeling advertising strategies is substantiated. Applied aspects of the use of simulation modeling are presented on the example model of the pharmaceutical enterprise advertising company. The model is implemented on the platform of the system of multi-threaded simulation AnyLogic. The expediency of using the proposed mathematical apparatus in increasing the efficiency of enterprises marketing activities is confirmed by the submitted results of simulation experiments.*

Keywords: *pharmaceutical enterprise; pharmaceutical market; advertising strategy; simulation modeling; simulation experiment; AnyLogic system.*

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МОДЕЛЮВАННЯ РЕКЛАМНОЇ СТРАТЕГІЇ ПІДПРИЄМСТВ НА РИНКУ ФАРМАЦЕВТИЧНОЇ ПРОДУКЦІЇ

Анотація. *У статті проаналізовано результати досліджень з формування рекламних стратегій промислових підприємств. Визначена специфіка розробки рекламних стратегій підприємствами фармацевтичної галузі. Зроблено огляд відомих застосувань математичного апарату в ході розв'язання проблеми. Обґрунтована необхідність використання імітаційного підходу в процесі моделювання рекламних стратегій. Прикладні аспекти застосування імітаційного моделювання представлені на прикладі моделі проведення рекламної компанії підприємством фармацевтичної галузі. Модель реалізована на платформі системи багатопідходного імітаційного моделювання AnyLogic. Доцільність використання запропонованого математичного інструментарію у підвищенні ефективності маркетингової діяльності підприємств підтверджена наведеними результатами імітаційних експериментів.*

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МОДЕЛИРОВАНИЕ РЕКЛАМНОЙ СТРАТЕГИИ ПРЕДПРИЯТИЙ НА РЫНКЕ ФАРМАЦЕВТИЧЕСКОЙ ПРОДУКЦИИ

Аннотация. В статье проанализированы результаты исследований по формированию рекламных стратегий промышленных предприятий. Определена специфика разработки рекламных стратегий предприятиями фармацевтической отрасли. Сделан обзор известных применений математического аппарата в ходе решения проблемы. Обоснована необходимость использования имитационного подхода в процессе моделирования рекламных стратегий. Прикладные аспекты применения имитационного моделирования представлены на примере модели проведения рекламной компании предприятием фармацевтической отрасли. Модель реализована на платформе системы многоподходного имитационного моделирования AnyLogic. Целесообразность использования предложенного математического инструментария в повышении эффективности маркетинговой деятельности предприятий подтверждена приведенными результатами имитационных экспериментов.

Ключевые слова: фармацевтическое предприятие; рынок фармацевтической продукции; рекламная стратегия; имитационное моделирование; имитационный эксперимент; система AnyLogic.

1. Introduction

The development of methodological and methodical principles of advertising activities in domestic enterprises is gaining important due to the activation of their marketing in the conditions of the consumer-oriented economy. Firstly, it concerns the problems of forming an advertising strategy, as one of the determining effectiveness factors of marketing and production activities of enterprises in general. However, the effectiveness of advertising remains low despite the significant increase in advertising costs in Ukraine during the last decade. Advertising strategy is a significant component of the business process, which is changing under the influence of information technology development. Today the main direction is the introduction of the digital marketing concepts as a complex of information and technological solutions. New types and forms of advertising are emerging based on modern digital technologies. It plays a special role for industries, which have flexible production and marketing systems, a significant of product market segmentation and high levels of competition. The pharmaceutical industry is one of these industries. In such conditions, the formation of advertising strategies requires serious preliminary diagnostics, assessment of the complex impact advertising measures on the production and financial performance of the research object, which, in turn, involves the attraction of a special mathematical apparatus. According to above situation, the simulation of advertising strategies for pharmaceutical companies is an urgent and timely task.

2. Analysis of research and publications of recent years

Domestic and foreign researchers [1; 2; 3; 4; 5] made a considerable scientific contribution to the development of problems of advertising activity. In addition, literary sources focuses on the use of mathematical apparatus for solving specific problems associated with the advertising process.

In work [6] proposes an approach to modeling advertising companies by means of network planning and management.

Among the most common applications, the using of optimal and economy-statistical methods are popular. Publications [7; 8; 9] is devoted to the questions of modeling advertising campaigns. The topical tasks are optimizing the cost on advertising company in predicting an increase in revenue from the sale of goods or services, determine optimal distribution of advertising campaign budget between types of advertising events – sources of mass media. To work with the mathematical model of an advertising company the relevant software products (as the smallest Excel spreadsheets) are often used because in the solution of these problems have to face multicriteria optimization. At the heart of the analysis of the linear mathematical model most commonly used is the simplex method, by which the search for an optimal solution, usually, is due to variations one group of variables. However, several groups of variables vary simultaneously in cases that are more complex. Often, optimization is the optimal allocation of the total amount funds allocated to an advertising company, taking into account the provision of the maximum number of buyers.

Researchers argue that it is possible to set the new causal relationships that specific for system if approach to the analysis of an advertising company from position of system analysis and consider individual promotional activities as elements of the system [9]. As example, the correlation relationship between advertising events, synergistic and emergent effects. In recent years, some projects are development with the use of simulation methods [10; 11; 12; 13].

3. Problem description

The problem of modeling the advertising strategies of pharmaceutical industry remains not fully disclosed despite existing scientific developments. This is due to the specifics of advertising companies exactly in this field on the one hand and to insufficient use of the mathematical apparatus suitable for solving specific problems on the other hand. Famous traditional mathematical applications are characterized by objective defects that reduce the effect of modeling the advertising activities of enterprises. The main ones are the impossibility to study processes in dynamics (taking into account the occurrence of processes in real time and changes in events) and the inability to take into account the influence of many stochastic factors on the external and internal environment of the enterprise. In this regard, in our opinion, it is expedient to use of a simulation modeling methods, which have so far very limited application.

4. Setting goals and objectives

The purpose of the article is the disclosure of the possibilities of simulation methods application in the process of formation advertising strategies of pharmaceutical enterprises. Task of the article is study the dynamics advertising of pharmaceutical enterprise in real time influenced of stochastic factors. Testing the model of advertising strategy by conducting various experiments.

5. The main material research

The goals of pharmaceutical advertising do not differ from the goals of advertising any product group and consists in attraction the buyer to the purchase of the advertised product. The specifics of the industry affects on advertising processes and the formation advertising strategies for pharmaceutical companies. The peculiarities of the advertising object and the target audience, the specifics of perception of pharmaceutical products by potential users, the necessity to adhere to the legislative regulation norms and self-regulation activity of pharmaceutical organizations are determine the specifics of advertising pharmaceutical products. The application of simulation models offers many advantages over the implementation of experiments on a real system and use of other methods, namely: cost, time, accuracy, visibility, universality, and others. The module of advertising strategies developed within the framework of creation complex model of production and sales system on pharmaceutical enterprise. It researches the impact of costs for any advertising sources on the income level in the context of various strategies of medicines promotion. The fragment of the model is shown in fig. 1.
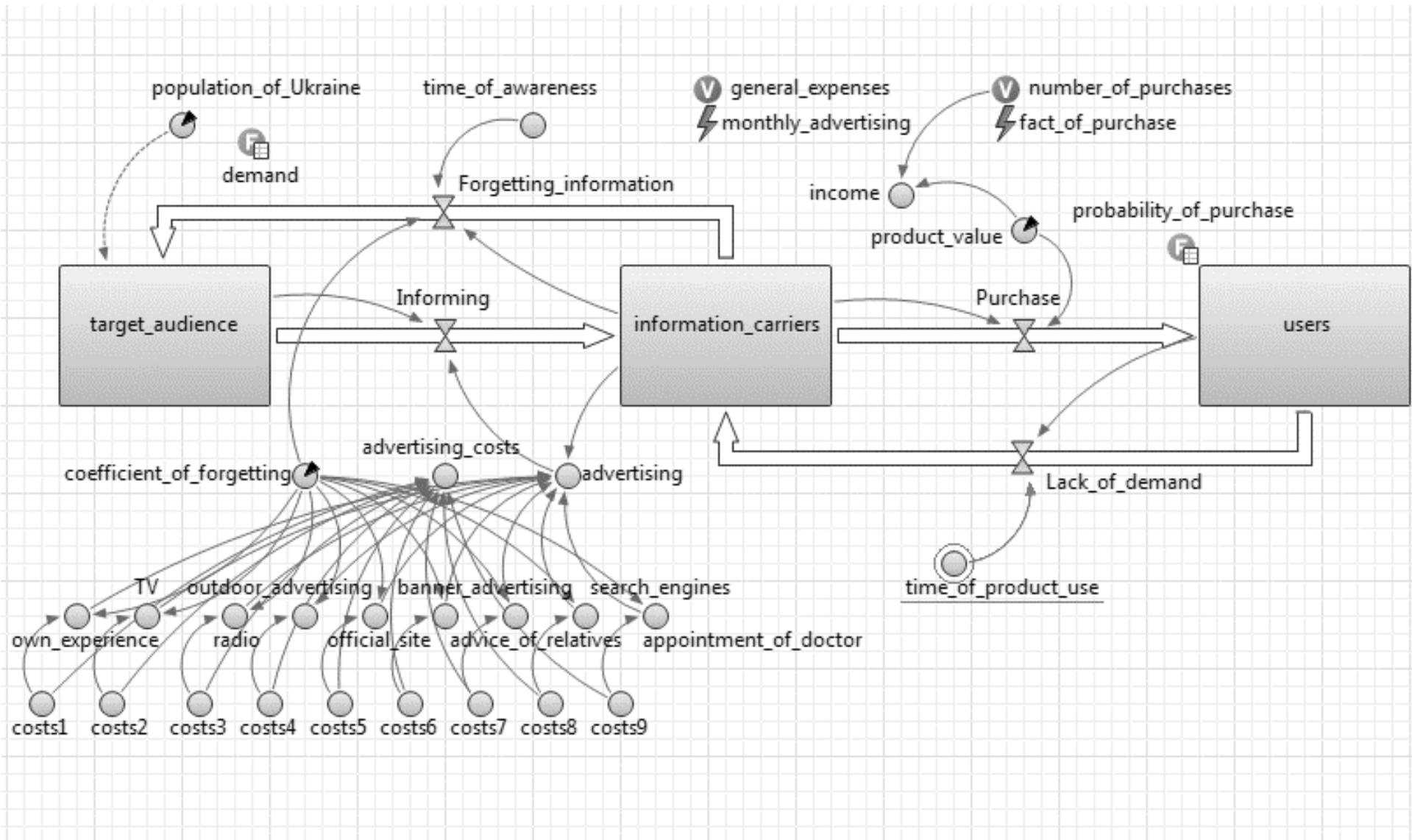
Fig. 1. Model of the advertising strategy of a new medicinal product (fragment)
(Developed by the authors)

The work of the module allows to adjust the necessary amount of expenses for advertising tools; to determine the reasonable period of the advertising campaign of pharmaceutical products; optimize the effectiveness of marketing costs, maximize revenue from advertising campaigns. The simulation model provides the opportunity for computer experiments to select the optimal combination of advertising strategies to minimize the cost of their implementation and maximize revenue from sales.

The software platform for the implementation of the model is the system of multilevel simulation modeling AnyLogic, which supports all existing simulation methods on the single platform (Discrete Event, System Dynamics, Agent-Based).

The system-dynamic fragment of the model is containing the following elements:
1. Reservoirs:
– Target_audience;
– Information_carriers;
– Users.
2. Streams:
– Informing;
– Purchase;
– Lack_of_demand;
– Forgetting_information.
3. Parameters:
– Coefficient_of_forgetting;
– Population_of_Ukraine;
– Product_value.
4. Table functions:
– Probability_of_purchase;
– Demand.
5. Variables:
– Number_of_purchases;
– General_expenses.
6. Developments:
– Fact_of_purchase;
– Monthly_advertising.

The remaining elements of the model belong to the category of Dynamic variables. The content of the streams is formed through parameters, dynamic variables or table functions. The demand function is formed by different algorithms depending on the particular market situation that is simulated.

Imitation experiments can be performed at different time periods with different duration of the simulation step. Time periods are determined by the user in the process of directly configuring the experiment. Approbation of the simulation model of the advertising company is considered on the example of pharmaceutical company open joint-stock company «Farmak» – one of the largest pharmaceutical manufacturers of various pharmacotherapeutic groups in Ukraine.

According to [14], the company's advertising costs for the first half of 2017 amounted to $ 28,725.8K. The company holds 6.5% of the market for pharmaceuticals among all manufacturers (including foreign producers) and 16.8% of the medicines market among Ukrainian producers [15].

In pharmacology, all medicines are divided into 5 groups: Vitamins and Supplements; Cough and Cold preparations; Immunostimulants; Cardiovascular preparations; Anesthetics and antispasmodics.

Creation and testing of the model is carried out on indicators of the group «Cardiovascular preparations». The demand function on this group for doing experiments is presented in fig. 2.
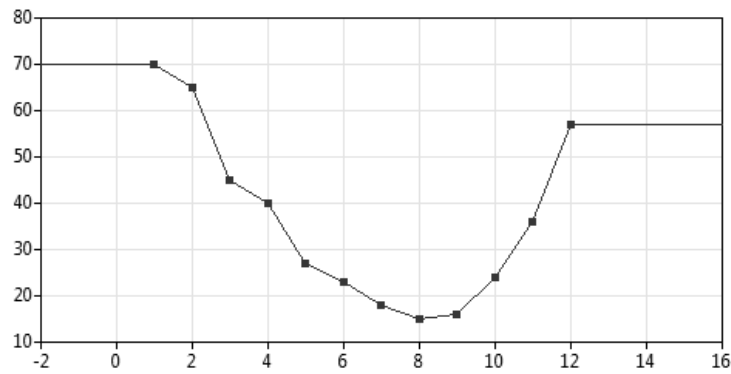
Fig. 2. Function of demand for cardiovascular preparation monthly, %
(Developed by the authors)

The main sources of informing potential buyers about medicines of this group with the corresponding rating are [14]:
− Appointment of a doctor (88%);
− Own experience (73%);
− Advice of relatives (39%);
− Search engines (30%);
− Official site (26%);
− TV (8%);
− Outdoor advertising (5%);
− Radio (5%);
− Banner advertising (4%);

The process of informing the target audience is described by the Nerlow-Errow model (N-A model), which has the form of differential equation of the 1st order:

$$\frac{dA}{dt} = b \cdot q(t) - k \cdot A, \tag{1}$$

when *A(t)* − knowledge about product (number of informed people about product in the *t* period);
q(t) − advertising activity (advertising costs in the *t* period);
b − advertising effectiveness (rating of the source of advertising);
k − the speed of information oblivion.

The cost of the product is an important parameter for making a decision on the purchase of a medicinal product. The probability of a product purchase depending on the cost of the product for the group of cardiovascular preparations is shown in fig. 3.
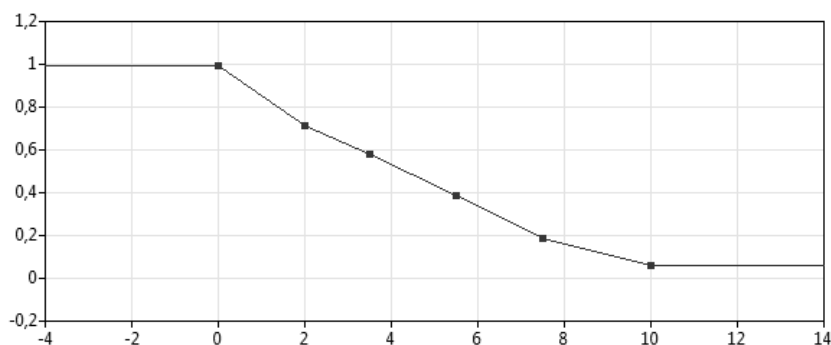

Fig. 3. The probability of purchase depending on the product cost, %
(Developed by the authors)

The monthly costs for different sources of advertising and the cost of the new product act as variables in carrying out experiments on the simulation model.

Suppose that advertising campaign for new product launches on one year. Model time – 12 months with step in 1 month. Let the advertising budget is evenly distributed among the medicines groups and the advertising of the new product accounts for 20% of the total advertising costs for the year. As follows, advertising costs of the new product should not exceed $ 2,300K for year. The advertising budget is distributed among the sources of advertising in accordance with their effectiveness (tab. 1).

Table 1

Funding for advertising sources (Developed by the authors based on [15])

Sources of advertising	Advertising costs	Amount of costs per year
Appointment of a doctor	31.6%	$ 726.8K
Own experience	26.3%	$ 604.9K
Advice of relatives	14.0%	$ 322.0K
Search engines	10.8%	$ 248.4K
Official site	9.4%	$ 216.2K
TV	2.9%	$ 66.7K
Outdoor advertising	1.8%	$ 41.4K
Radio	1.8%	$ 41.4K
Banner advertising	1.4%	$ 23.0K

Experiment 1. The costs of advertising a new product are evenly distributed over the entire simulation period. For each run of the model, the cost of the product is $ 0.75, $ 2.60, $ 4.45, $ 6.30, $ 8.60, $ 11.50 respectively.

If product cost is $ 0.75, the annual income is $ 60,251.50K.
If product cost is $ 2.60, the annual income is $ 171,103.18K.
If product cost is $ 4.45, the annual income is $ 235,188.43K.
If product cost is $ 6.30, the annual income is $ 233,044.37K.
If product cost is $ 8.60, the annual income is $ 152,818.79K.
If product cost is $ 11.50, the annual income is $ 97,226.99K.

The times schedule for changing the parameters: target_audience, information_carriers, users are shown in fig. 4.
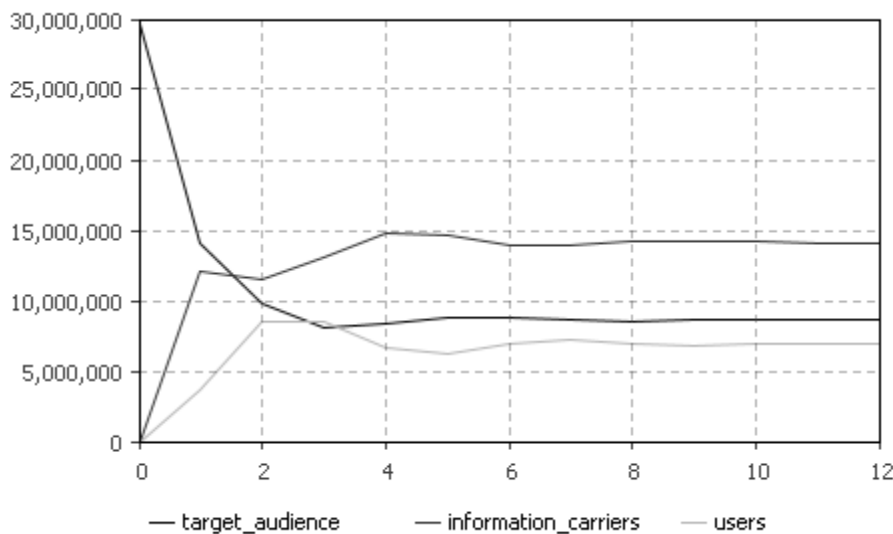

Fig. 4. The times schedule of the parameters: target_audience, information_carriers, users
(Developed by the authors)

Fig. 4 is shown that the first 3 months of advertising is quite effective, but starting from the 4th month, advertising costs are unfounded and do not have the expected response of the target audience. Such conclusions led to the second cycle of experiments.

Experiment 2. The costs of advertising a new product are evenly distributed for the first 3 months, and since the 4th month of the simulation are make up $ 0. For each run of the model, the cost of the product is $ 0.75, $ 2.60, $ 4.45, $ 6.30, $ 8.60, $ 11.50 respectively.

> If product cost is $ 0.75, the annual income is $ 60,617.86K.
> If product cost is $ 2.60, the annual income is $ 172,025.45K.
> If product cost is $ 4.45, the annual income is $ 236,312.50K.
> If product cost is $ 6.30, the annual income is $ 233,997.46K.
> If product cost is $ 8.60, the annual income is $ 153,340.94K.
> If product cost is $ 11.50, the annual income is $ 97,534.72K.

The times schedule for changing the parameters: target_audience, information_carriers, users are shown in fig. 5.

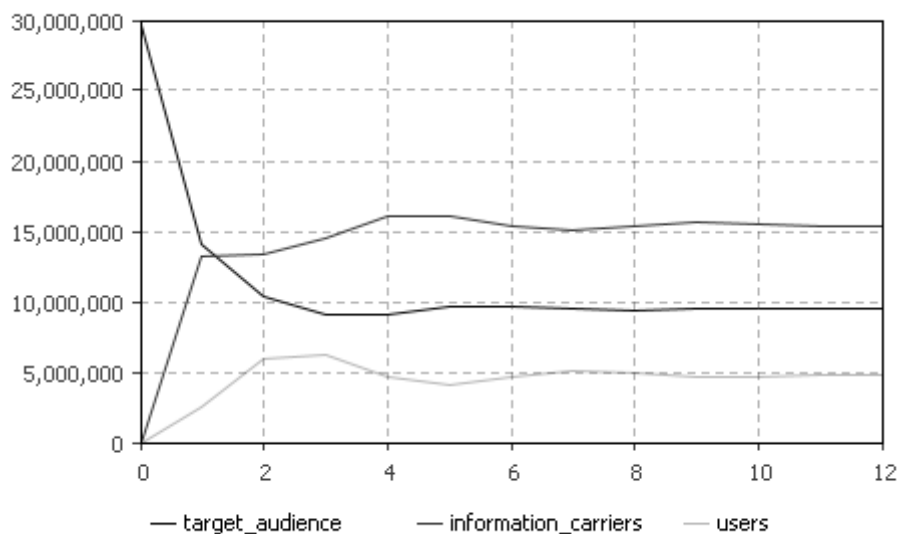

Fig. 5. The times schedule of the parameters: target_audience, information_carriers, users
(Developed by the authors)

Fig. 5 is shown that after the cessation of advertising, the number of users decreased significantly, the level of information carriers increased significantly. Such conclusions led to the third cycle of experiments.

Experiment 3. The 80% of annual cost of advertising a new product is evenly distributed in the first 3 months, the last 20% is evenly distributed over the next 9 months. For each run of the model, the cost of the product is $ 0.75, $ 2.60, $ 4.45, $ 6.30, $ 8.60, $ 11.50 respectively.

> If product cost is $ 0.75, the annual income is $ 60,558.88K.
> If product cost is $ 2.60, the annual income is $ 171,877.05K.
> If product cost is $ 4.45, the annual income is $ 236,132.18K.
> If product cost is $ 6.30, the annual income is $ 233,845.09K.
> If product cost is $ 8.60, the annual income is $ 153,257.48K.
> If product cost is $ 11.50, the annual income is $ 97,485.51K.

The times schedule for changing the parameters: target_audience, information_carriers, users are shown in fig. 6.

Fig. 6 is shown that the uneven distribution strategy of advertising budget between the first and last months of advertising keeps the number of users at a rather high level. A high part of target audience are carriers of information.
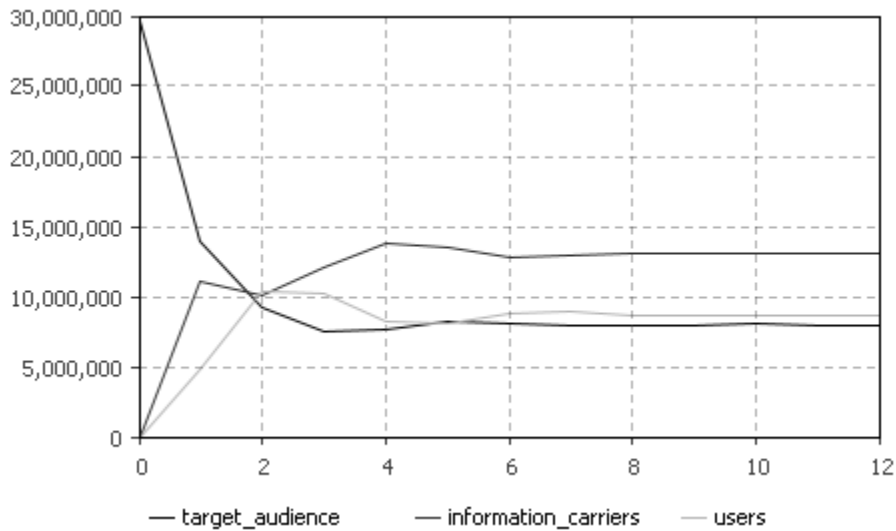
Fig. 6. The times schedule of the parameters: target_audience, information_carriers, users
(Developed by the authors)

Common amounts of incomes, that received as a result of the experiments, are presented in tab. 2.

Table 2

Amounts of incomes received as a result of experiments (Developed by the authors)

Advertising costs / Product cost	Experiment 1	Experiment 2	Experiment 3
< $ 2	$ 60,251.50K	$ 60,617.86K	$ 60,558.88K
$ 2–$ 3.5	$ 171,103.18K	$ 172,025.45K	$ 171,877.05K
$ 3.5–$ 5.5	$ 235,188.43K	$ 236,312.50K	$ 236,132.18K
$ 5.5–$ 7.5	$ 233,044.37K	$ 233,997.46K	$ 233,845.09K
$ 7.5–$ 10	$ 152,818.79K	$ 153,340.94K	$ 153,257.48K
> $ 10	$ 97,226.99K	$ 97,534.72K	$ 97,485.51K

Tab. 2 is shown that the optimal strategy for distribution advertising costs to maximize income is strategy of experiment 2, when the entire budget is spent in the first months, and in recent months advertising costs are zero.

However, if the company's management is more interested in the increased market share, then it needs to be guided by the strategy of experiment 3. The level of income in this case is slightly lower, but the number of users of the new product significantly increases.

The company will obtained the highest level of income from any advertising strategy when establishing a product cost ranging from $ 3.5 to $ 5.5.

5. Conclusions

The presented fragment is a module of the general model of definition and analysis the advertising strategy of enterprises, in particular, objects of the pharmaceutical industry.

The simulation model of the marketing activity of the pharmaceutical enterprise is allowed to analyze the current state of affairs in a short time, optimize the company's current activities, reduce advertising costs and develop a plan for further action. The conducted simulation experiments have proven the feasibility of using the proposed mathematical and simulation tools in increasing the efficiency marketing activities of enterprises.

Further research will focus on the development the analytical component of the model, as well as the planning and implementation of optimization experiments using various target optimization functions.

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