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## **SIMULATION MODEL AS A DIGITAL MARKETING TOOL AT THE MICRO LEVEL**

**Abstract.** The areas of application of digital technologies at the micro level are defined. The urgency of using model-simulators as digital marketing tools on an example of the pharmaceutical industry is proved. The model-simulator of formation of the advertising strategies of pharmaceutical companies as important components of general marketing strategies is offered. The software platform for creating the model is AnyLogic system. The experimental base, obtained as a result of operation of the model-simulator, is analyzed. Possibilities of various types of experiments carried out using the multilevel paradigm of simulation are shown according to the data of the leading enterprises of the domestic pharmaceutical industry. The questions about involving the cloud technologies and scenarios for their use are considered in the framework of application of model-simulators in the process of making managerial decisions.

**Jel Classification System:** M31, M37, C63

**Keywords:** digital marketing, marketing strategy, pharmaceutical company, simulation modeling, model-simulator, multilevel simulation paradigms, simulation experiment, AnyLogic system, cloud technologies.

**Introduction.** Digital marketing, as a complex of information solutions, is one of the basic components of the development of modern Ukrainian

business<sup>158</sup>. However, its potential is not fully utilized despite certain achievements. Specialists determine the following options for the application of digital technologies at the micro level<sup>159</sup>:

- using the Internet as a means of finding information, ordering goods and services.
- availability of an organization's Web site with information that says about the company and offered products.
- using the Internet as an independent business.
- including the Internet in the contour of business: the business structure is preserved, but more or less fully the opportunities of digital marketing are using, which, accordingly, increases the efficiency of the business itself.

The urgency of digital technologies in the course of marketing activities is particularly significant for industries with flexible production and marketing systems, high levels of competition, a significant segmentation of the commodity market, import dependence along with sustained growth and innovative direction<sup>160</sup>. In particular, the pharmaceutical industry is included in these industries.

The main trend of the Ukrainian pharmaceutical market is the competition between domestic and foreign producers. Therefore, the top priorities of marketing policy for each company-manufacturer are the following:

- A study of market demand for pharmaceutical products, that is, the benefits of specific groups of potential users, which include medical staff and directly users-patients.

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<sup>158</sup>Lamberton, C. & Stephen, A.T. (2016). A Thematic Exploration of Digital, Social Media, and Mobile Marketing: Research Evolution from 2000 to 2015 and an Agenda for Future Inquiry. *Journal of Marketing*. – № 80(6). – pp. 146-172.

<sup>159</sup>Lyulchak, Z. (2012). State and perspectives of digital-marketing development. *Bulletin of Lviv Polytechnic National University*. – № 749. – pp. 200-206.

<sup>160</sup>Bleier, A., Harmeling, C.M. & Palmatier, R.W. (2019). Creating Effective Online Customer Experiences. *Journal of Marketing*. – № 83(2). – pp. 98-119.

- Formation of an innovative-active product strategy that meets the requirements of the market.
- Development of an effective pricing policy.
- Formation of balanced advertising strategies for the promotion of products in the relevant segments of the pharmaceutical market.
- Development of specific marketing activities with taking into account the actions of competitors.

According to the stated tasks, the information problem of pharmaceutical companies is to provide prompt support for the exchange and storage of large volumes of information with a high degree of safety. It matters both for a particular pharmaceutical company and for the industry as a whole – from the point of view of ensuring its competitiveness and development in the conditions of the expansion of foreign manufacturers.

At the same time, the potential range of digital marketing opportunities is much wider. Many literary sources of domestic and foreign authors is devoted to consideration of its tool base and directions of its application in the pharmaceutical industry <sup>161</sup>. The tools of analytics, development and promotion of managerial decisions in conditions of an indefinite business environment of the enterprises operation occupy a separate niche. One of the most advanced platforms for creating such tools is simulation modeling.

The three main existing paradigms of simulation modeling – Discrete Event, System Dynamics and Agent Based – are used to create model-simulators with application in various branches of the economy. Relevant applications are regularly presented in professional international forums: Winter Simulation Conference (WSC), International System Dynamics Conference, ASIM (German-speaking community of simulation modeling), IMMOД («Simulation modeling. Theory and practice»), European congress EUROSIM, webinars and publications by one of the world's leading organizations in the field – The AnyLogic Company.

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<sup>161</sup>Jawaid, M. & Ahmed, S.J. (2018). Pharmaceutical Digital Marketing and Its Impact on Healthcare Physicians of Pakistan: A National Survey. *Cureus* – № 10(6).

However, the proliferation of simulation modeling in the area of creation of marketing strategies for the development of domestic enterprises is still negligible. This also applies to pharmaceutical companies. Although the pharmaceutical companies of the world in recent years began to address the introduction of simulation technologies. Latest examples:

- Developments of the Sterling Simulation consulting firm for pharmaceutical manufacturers: agent model of pharmaceutical marketing <sup>162</sup>.
- Developments by Bayser Consulting firm regarding the launch and promotion of a pharmaceutical product: agent model of launch strategy formation <sup>163</sup>.

An additional proof is that the theoretical and applied achievements in using simulation in other areas make it possible to position this mathematical apparatus as a flexible tool for making managerial decisions. The experimental database of marketing information obtained in this study confirms this reference.

Any simulation model is an integrated environment for the study of stochastic processes of different nature in dynamics with parametric settings for specific conditions and experiments. Migration of simulation calculations into the cloud especially promotes development of their use as tools of digital marketing.

The main areas of using cloud technology in simulation are <sup>164</sup>:

- Using the cloud as computing power. This is especially true for "multi-pass" types of experiments: Monte Carlo, Variation of parameters, Optimization.

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<sup>162</sup> Sterling Simulation. A Pharmaceutical Company Decides on a Marketing Strategy Using Agent-Based Modeling. Available at: <https://www.anylogic.com/a-pharmaceutical-company-used-agent-based-modeling-to-decide-on-a-marketing-strategy/>.

<sup>163</sup> Bayser Consulting. Modeling of a Pharmaceutical Product Launch. Available at: <https://www.anylogic.com/modeling-of-a-pharmaceutical-product-launch/>.

<sup>164</sup> Borschev, A. (2017). Migrating simulation to the cloud. IMMOD-2017. Available at: <http://simulation.su/uploads/files/default/2017-immod-18-26.pdf>.

- Using the browser as a universal environment for working with the model: working with versions of the model; task of input parameters; planning and implementation of complex experiments; review, analyze and export results; providing animation of a remotely implemented model and implementing its interactivity (interactive model management while performing experiments).
- Cloud technologies as a general platform for collaborative work with models. In fact, something like a social network for simulation models occurs when working with models that are in the cloud.
- Using the cloud to deliver the model to the customer.

The security issue is particularly acute in conditions of using cloud-based applications. The policy of pharmaceutical companies inherent in this type of business does not facilitate the placement of data in third-party cloud services. At the same time, the refusal of their functionality can cause significant losses for the volumes and efficiency of the calculations. A universal solution to this problem is the use of the private cloud (cloud-based applications deployed on the private infrastructure of the company)<sup>165</sup>. It is also possible to lease a cloud provider share.

Thus, from the point of view of using model-simulators as tools of digital marketing, an important issue is not only the mathematical implementation of models, but also the choice of software platform for its implementation. Incidentally, this is important both for planning and conducting simulation experiments, and for providing efficient cloud migration, storage and data security capabilities.

One of the most powerful modern software platforms for the creation of industrial simulation applications is the system of multi-level simulation AnyLogic. The system supports all basic simulation approaches and their combinations, provides customization of various types of simulation experiments: Standard, Optimization, Variation of parameters, Comparison of

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<sup>165</sup>Gowresh, N., Brundha, E.J. & Murthy, N. (2015). A Survey on Privacy Preserved Mobile-Access Health Care Data with Auditability using Cloud. *International Journal of Innovative Research in Computer and Communication Engineering*. – №3(5). – pp. 170-176.

runs, Sensitivity analysis, Monte-Carlo, Calibration, Non-standard. The issues of information security and support of processes of using cloud technologies are solved based on this platform.

The system provides sufficiently visual of conducting experiments. AnyLogic Cloud uses graphic technology to support animation – the canvas technology for 3D animation and SVG (Scalable Vector Graphics) technology to support 2D animation.

The use of cloud-based technologies ensures the collective work of users with models created in the AnyLogic environment. AnyLogic Cloud implements user-friendly technology, which stores the input parameters and results of all model, runs according to the specific parametric settings in a single database. It does not matter which user ran the model before: if the parameters are found in the general database, no imitation is performed. That is, a particular user can take advantage of results previously obtained by other users. Thus, the principle of collective work with simulators is realized in practice, which, of course, is convenient and can be successfully used in the process of developing and making managerial decisions due to a significant reduction in the time of conducting "multi-pass" experiments.

According to the above, the choice of AnyLogic system as a platform for the creation of model-simulators for the marketing activities of pharmaceutical companies can be justified by the peculiarities of their functioning in an uncertain highly competitive environment - intense changes in the supply of new products and the changing market demand, seasonal component, storage characteristics and transportation of medicines, etc.

Any company is interested in increasing sales and expanding its client base, but the means to achieve these goals are not always obvious. To select the most rational marketing and sales strategy, professionals need to analyze a huge number of factors that affect its success, for example: levels of income, product features, competitors' actions, trends in the development of modern technologies, market and customer requirements, production capacity, market segmentation, national features of potential buyers. In addition, most of the factors must be considered in the dynamics.

Due to the use of simulation technologies, the cost and complexity of research is significantly reduced, that is very significant for the pharmaceutical industry.

Pharmaceutical products have a significant range, which is constantly changing according to industry specifics. Individual medicines groups differ in technology of production, control, storage and promotion in the relevant segments of the pharmaceutical market. This creates the need for continuous study of target audience and targeting them to advertising companies.

The leading pharmaceutical companies in the world are spending a lot of money on researching the impact of marketing (in particular, advertising) strategies on specific target groups of potential users in the industry. The results of such research are of interest due to the fact that global companies are developing and introducing innovative pharmaceutical products on the market, and therefore are "legislators" of marketing strategies. Perhaps, to a lesser extent, but similar studies are conducted in different countries of the world, demonstrating the wide geography. Let us consider some examples.

The results of research, aimed at identifying the relationship of target groups of pharmaceutical users with specific sources of information that influence their choices, are important. That is, the behavior of users is studied in relation to information retrieval channels (one of the applications of digital marketing).

Certain developments are devoted to the study of factors influencing the preferences of medical personnel of hospitals in the process of forming their recommendations to patients <sup>166</sup>. The results are based on cross-sectional studies conducted on the basis of private and public hospitals in the Karachi city, as well as information from national and transnational pharmaceutical companies operating in Pakistan. Although data processing was automated and realized using the AMOS 7 package, the complexity of the research led to

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<sup>166</sup>Ahmed, R. R., Vveinhardt, J., Streimikiene, D. & Awais, M. (2016). Mediating and marketing factors influence the prescription behavior of physicians: An empirical investigation. *Amfiteatru Economic*. – № 18(41). – pp. 153-167.

a significant limitation the number of intermediaries (doctors, pharmaceutical staff) and marketing factors that were subject to study.

Materials from similar empirical studies are presented by scholars from Asia <sup>167</sup> and America <sup>168</sup>. In particular, the latter study in detail the effect of direct and contact advertising.

Researchers from Italy <sup>169</sup> presented a model of the target audience's behavior of users of unpatented medicines. The model takes into account a large number of factors of influence - demographic, self-identification, previous behavior, perceptions of risks, etc. The object of the study was the Italian market of unpatented medicines. The aim of the research was to develop marketing activities (in particular, the use of digital technologies) to reduce the risks of the use and promotion of non-proprietary medicines within the "high-risk" groups of users.

Field studies, undoubtedly, are very important. However, only reducing the complexity and cost of experiments will make them accessible to most firms. At the same time, it is worth considering that significant costs not always are associated with a correspondingly significant effect. This thesis can be illustrated by the results of research by scientists from Washington <sup>170</sup>. Materials from 25 significant field experiments with large American retailers and brokerage companies (with millions of customers and spending more than \$ 2.8 million on digital advertising) have proved that measure the impact of advertising is difficult (virtually impossible). At the same time, it has been proved that the holding of experimental advertising companies amounted to more than 10 million man-weeks, so it is considered appropriate in terms of academic study of the process itself.

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<sup>167</sup> Biswas, K. & Ferdousy, U. K. (2016). Influence of Pharmaceutical Marketing on Prescription Behavior of Physicians: A Cross-sectional Study in Bangladesh. *Journal of Accounting & Marketing*. – № 5(2). – pp. 1-4.

<sup>168</sup> Costea, D., Carter, F., Chou, S.-Y. & King, A. (2012). Is Advertising Effective or Not? Evidence from the Pharmaceutical Market. *NMIMS Management Review*. – № 12. – pp. 9-28.

<sup>169</sup> Zerbini, C., Luceri, B. & Vergura, D. (2017). Leveraging consumer's behaviour to promote generic drugs in Italy. *Health Policy*. – № 121(4). – pp. 397-406.

<sup>170</sup> Lewis, A. & Rao, J. M. (2015). The unfavorable economics of measuring the returns to advertising. *The Quarterly Journal of Economics*. – pp. 1941–1973.



Attracting the mathematical apparatus contributes to increasing the effectiveness of the process of forming marketing strategies of enterprises. In particular, in the field of research of advertising as a component of general marketing strategy, there is certain experience of domestic and foreign scientists <sup>171</sup>. Certain scientific developments contain a detailed overview of literary sources on the use of mathematical methods in the field of dynamic advertising <sup>172</sup>.

In general, optimization methods were the most widespread. An example of defining an analytical solution to the problem of evaluating the effectiveness of advertising is the work of Russian scientists <sup>173</sup>. It presents a model of optimal management of advertising costs. The decision of the optimization problem is reduced to the solution of the system of non-linear integral equations of Volterra type and integral functionality of quality.

However, the use of classical mathematical methods, as a rule, reduce the complexity of computations not significantly, and most importantly, obtaining an analytical solution is not always possible in the absence of clear algorithmic dependencies and recursiveness of formulas.

Analysis of advertising capital in the pharmaceutical industry, developing and making managerial decisions on the distribution of capital by sources of advertising is the main trend of research by scientists in the West. Simulation is a modern apparatus for the application of model-simulators, aimed at the introduction and prediction of the effects of any management decisions.

The use of simulation models offers many advantages over the implementation of experiments over a real system and the use of other methods, namely: cost, time, accuracy, visibility, universality, etc. The simulation model of the pharmaceutical company's marketing activity allows

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<sup>171</sup>Leeflang, P. S. H. & Wieringa, J. E. (2010). Modeling the effects of pharmaceutical marketing. *Marketing Letters*. – № 21(2). – pp. 121-133.

<sup>172</sup>Huang, J., Leng, M. & Liang, L. (2012). Recent Developments in Dynamic Advertising. *European Journal of Operational Research*. – № 220(3). – pp. 591–609.

<sup>173</sup>Lutoshkin, I. V. & Iamaldinova, N. R. (2016). The existence of a solution to the problem of managing advertising expenses with distributed delay. *News of Irkutsk State University*. – № 18. – pp. 48–59.

management to analyze in a short time the current state of affairs, optimize the current activities of the company, reduce the cost of advertising, and develop a plan for further action.

The leading hypothesis of this study is to prove the possibility of using model-simulators in the formation of pharmaceutical companies' advertising strategies as important components of common marketing strategies implemented on the platforms of information and digital technologies.

The research objects are leading enterprises of the domestic pharmaceutical industry – OJSC "Farmak", Corporation "Arterium", CJSC "Pharmaceutical firm "Darnitsa".

The environment for the development of models is the system of multilevel simulation modeling – AnyLogic.

Within the framework of creating the model complex of the production and marketing system of the pharmaceutical company, a model-simulator was developed – a module of the advertising activity of the enterprise. The methods of System Dynamics and Agent-Based modeling are used. Developed within the complex, the model-simulator is aimed at working out the following solutions in the field of strategic advertising:

- Investigating the optimal level of prices for the product assortment in order to maximize revenue from sales.
- Minimizing advertising budget and its distribution to promote original and generic medicines.
- Monitoring the effectiveness of researching new medications and reproduction of existing ones, depending on the duration of the life cycle.
- Determining the preferences of potential buyers depending on the level of demand and prices for assortment.
- Monitoring and forecasting the reaction of the target audience to product advertising, tracking the level of information about the product, etc.

The model-simulator allows creating the basis for making grounded decisions, which is quite typical for the enterprises of the studied area. This is facilitated by a large number of types of experiments that offer modern

platforms of multilevel simulation modeling. AnyLogic tools allow conducting various experiments by type of analysis:

- Standard (simple) experiment. Launches a model with predefined values of parameters, supports virtual and real time modes, animation, and debugging of the model.
- Variation of parameters. Performs several "runs" of the model with variations of one or more parameters, with the ability to use replication.
- Comparison of "runs". Allows interactively setting different parameters values and running a model with these values. Visually compares the results of "runs" in scalar form or in the form of data sets.
- Optimization. Finds the values of the parameters at which the optimal value of the given target function is achieved. There may be a number of constraints on the values of the parameters and variables of the model. The optimization progress schedule is displayed.
- Sensitivity analysis. Performs several "runs" of the model, varying the value of parameter and showing how the simulation results depend on these changes.
- Calibration. The values of the model parameters are fitted with the help of the optimizer, with which the results of the simulation most accurately correspond to the given data. Data can be given in scalar form or in the form of data sets. The visualization of the calibration progress and the results correspondence to each given criterion is carried out.
- Monte-Carlo. Gets and displays a set of simulation results for a stochastic model or for a model with stochastically changing parameters.
- Non-standard. Launches an experiment with a non-standard script that is completely written by the user. The experiment has not got built-in graphical interface or definite behavior.

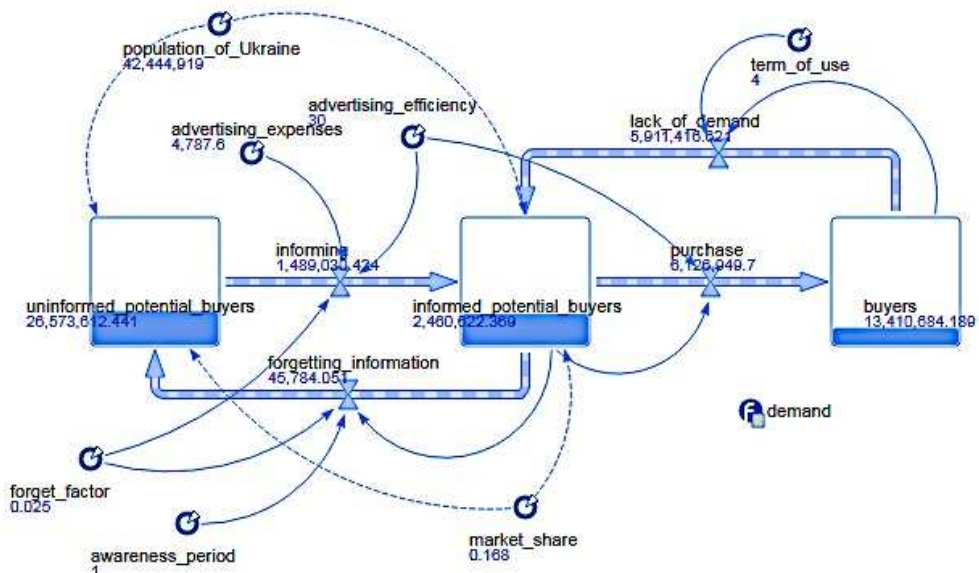
Performing a Standard experiment allows management to adjust the required amount of expenses for advertising tools; to determine the reasonable period of the advertising campaign of pharmaceutical products; to optimize the effectiveness of marketing costs; to maximize revenue from advertising campaigns. The simulation model provides the possibility of

conducting computer experiments with the aim of choosing the optimal combination of advertising strategies to minimize the costs of their implementation, provided they maximize revenue from sales.

The built-in model-simulator allows management to perform a Simple experiment with three levels of detail advertising costs:

1. advertising costs are presented in the general form (Figure 1). The components of advertising costs remain unknown to the user, it cannot affect individual sources of advertising.

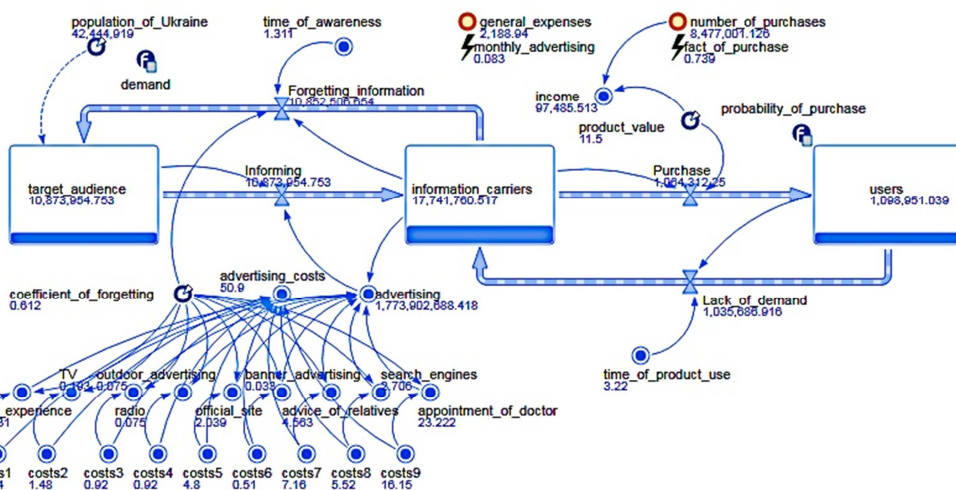
Figure 1. The first level of detail the advertising costs



Source: compiled by the authors on the basis of the research

2. Advertising costs are represented by variable accumulating due to the main sources of advertising, including Internet resources (Figure 2).

Figure 2. The second level of detail the advertising costs



Source: compiled by the authors on the basis of the research

The main sources of informing potential buyers about the medicines of this group with the corresponding rating are <sup>174</sup>:

- own experience (87%);
- appointment of a doctor (79%);
- the advice of a pharmacist in a pharmacy (58%);
- recommendations of native / friends (55%);
- searching for information on the Internet through search engines (27%);
- search for information on the Internet on specialized websites (23%);
- advertising on television (14%);
- recommendations of forum users (12%);
- expert advice on a specialized site (11%);
- recommendations of friends in social networks (10%);
- on-line advertising (4%);
- advertising on sales places (4%);
- magazines / newspapers (2%).

<sup>174</sup>Smirnova A. Digital Pharma – farm market analysis reports. Available at: <http://adpage.com.ua/digital-pharma-аналитические-отчеты-о-фарм-рынке>.

Foreign authors conduct many researches on the effectiveness of Internet advertising <sup>175</sup>, so this level of detail of advertising costs can be applied as a mathematical apparatus for the implementation of such studies. However, such a significant level of detail is complicating the model, significantly increasing the number of variables, which adversely affects the speed of user queries.

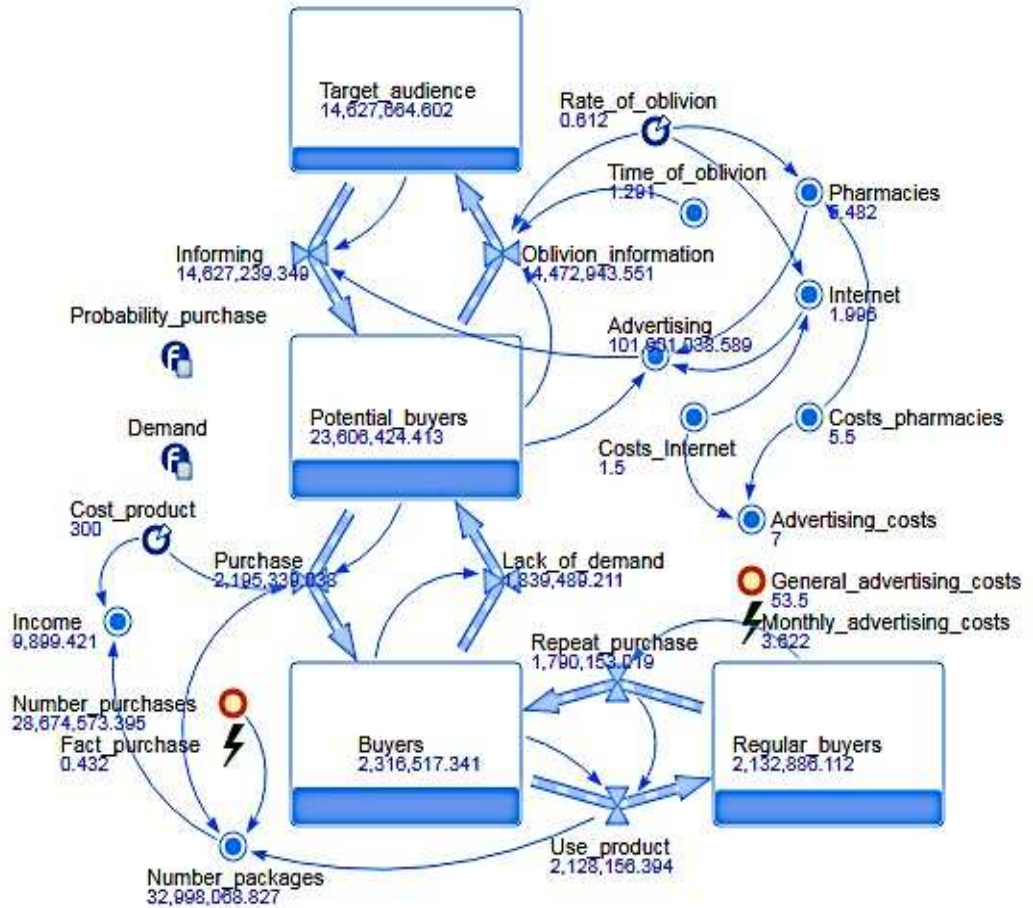
3. advertising costs are represented by variable accumulating due to expenses of promotion in Internet sources and promotion in pharmacy points (representatives) (Figure 3).
4. this level of advertising costs is optimal. The model is fast, the conditions for expansion and deepening are given, a new storage is added – Regular\_buyers.
5. experiment Variation of parameters is a procedure for evaluating the influence of input hypotheses and the values of key factors on the model's indicators output. The experiment with variation of model parameters helps to assess how sensitive the model's forecast is to change the hypotheses underlying it.

AnyLogic provides a mechanism for automatically launching a model for a given number of times with a change in the value of the selected parameter. This experiment performs several "runs" of the model, varying the value of one of the parameters and showing how the simulation results depend on these changes. When experiment is run, it is possible to study and compare the behavior of the model at different values of the parameters using graphs.

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<sup>175</sup>Zhang, Y., Trusov, M., Stephen, A.T. & Jamal, Z. (2017). Online Shopping and Social Media: Friends or Foes? *Jornal of Marketing*. – № 81(6). – pp. 24-41.

Figure 3. The third level of detail the advertising costs



Source: compiled by the authors on the basis of the research

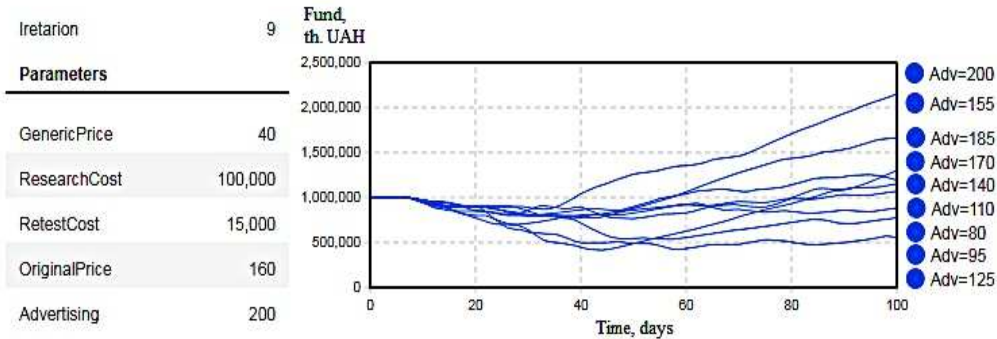
The experiment Variation of parameters was conducted to assess the dynamics of capital change, depending on the parameter Advertising (Figure 4).

The figure 4 shows that capital growth occurs when advertising costs amount to at least 140 th. UAH. Otherwise, the company may suffer significant losses.



Figure 4. The experiment Variation of parameters

## Pharma : Parameters\_Variation



Source: compiled by the authors on the basis of the research

Considering medicines as a market product category, the understanding of the terms "original" and "generic" (reproduced) medication is also important. The original (innovative) medicinal product is the product, first introduced to the pharmaceutical market, containing a new synthesized or received in another way active pharmaceutical ingredient, authorized for medical use and patented for a certain period of time. A reproduced medicinal product (generic) is a copy, which corresponds to an innovative (original) medicinal product by therapeutic efficacy and safety. It is manufactured by a pharmaceutical company after expiration of the patent protection period<sup>176</sup>.

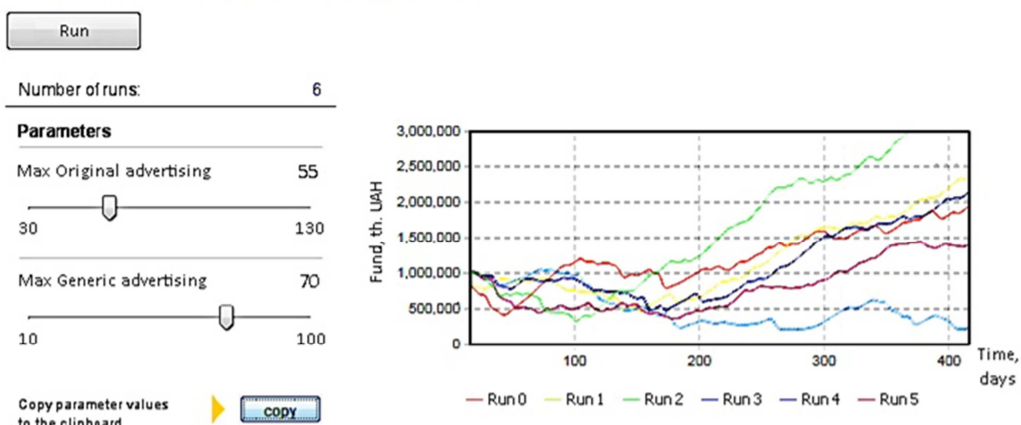
Promotion of the pharmaceutical company's product portfolio can also be divided into two parts: the cost of advertising for original medicines and the cost of advertising generic medicines. Company management regularly makes informed decisions about the distribution of capital between these two flows. The results of experiments Comparison of "runs" can serve as the basis for making such decisions. This type of experiment during execution allows the user to customize the selected parameters in any combination and displays all the "runs" on one graph. (Figure 5).

<sup>176</sup>Levytska O. (2016). Medicinal products as objects of the pharmaceutical market (part 2). *Pharmacist Practitioner*. Available at: <http://fp.com.ua/articles/likarski-zasobi-yak-ob-yekti-farmatsevtichnogo-rinku-chastina-2/>.



Figure 5. Experiment Comparison of "runs"

### Pharma : Comparison\_of\_runs



Source: compiled by the authors on the basis of the research

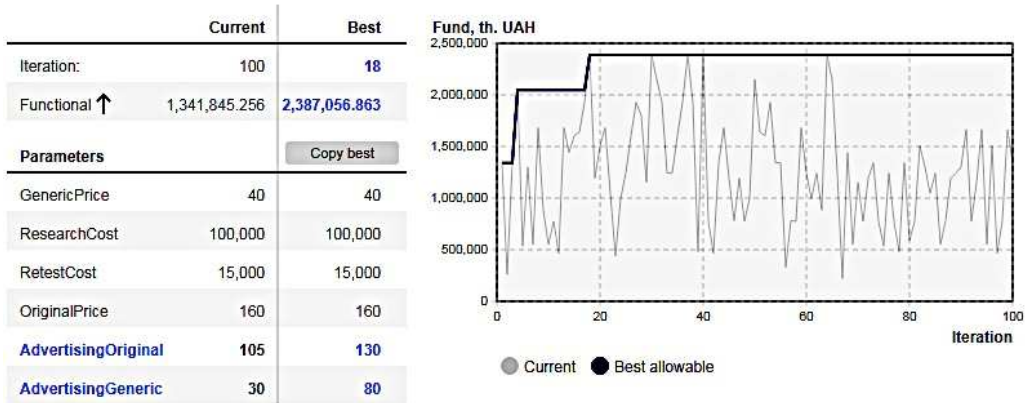
The graph clearly shows that the maximum increase in capital occurs in the settings corresponding to Run 2. The worst combination of parameters is Run 3.

Experiment Comparison of "runs" serves to visualize the dependence of the output variable on the input parameters. There is a need to use the Optimization experiment to quickly find the optimal values of all input parameters to achieve the best result. The Optimization experiment looks for the value of the parameters at which the optimal value of the given target function is achieved – maximization or minimization.

Thus, the implementation of the Optimization experiment to maximize the size of capital, depending on the cost of advertising for original and generic medicines, has allowed finding the optimal values of these parameters (Figure 6).

Figure 6. Optimization experiment

### Pharma : Optimization



Source: compiled by the authors on the basis of the research

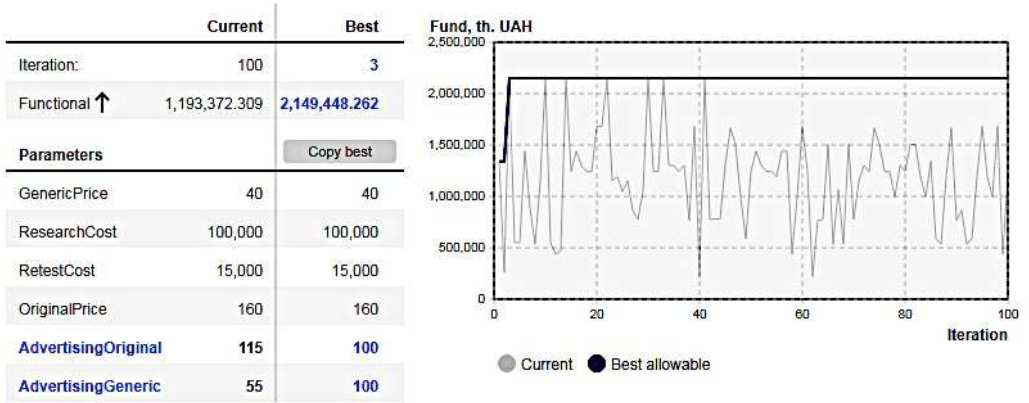
The system executed 100 iterations and determined that the maximum capital gain is achieved at the 18th iteration, when AdvertisingOriginal costs are 130 th. UAH, and AdvertisingGeneric is 80 th. UAH. The total amount of advertising costs was 210 th. UAH.

It is a possible case when the firm does not have sufficient amount to finance advertising costs at the optimal level. For example, the total advertising costs should be no more than 200 th. UAH. In this case, the Optimization experiment is subject to restriction (Figure 7).

Given the restriction of advertising capital, the optimal cost of advertising for original and generic medicines was 100 th. UAH, the growth of capital during the simulation decreased by almost 140,000 th. UAH. That is, the reduction of initial advertising capital by 10 th. UAH has led to a loss of profit of 140,000 th. UAH. Such a conclusion can serve as an incentive to find additional investments and increase the initial capital for advertising, because then the company will not only pay off investors, but will also receive significant profit.

Figure 7. Optimization experiment with restriction

Pharma : Optimization



Source: compiled by the authors on the basis of the research

For large pharmaceutical companies operating throughout Ukraine and abroad, the analysis of data from specific regions to determine the optimal plan for advertising strategy is the necessary condition for successful business. For example, quite different levels of morbidity, provision of pharmacies and special stores, citizens' incomes, medical expenses, age limits of the population, etc. exist in different regions of Ukraine. Taking decisions on price setting for medicines, distributing funds from sources of advertising, placing drugs on pharmacies depending on demand and other complex issues in each region for managers of pharmaceutical companies is a priority task.

AnyLogic tools allow companies to build a model that takes into account the characteristics of different regions of the country and collects consolidated statistics for selected parameters.

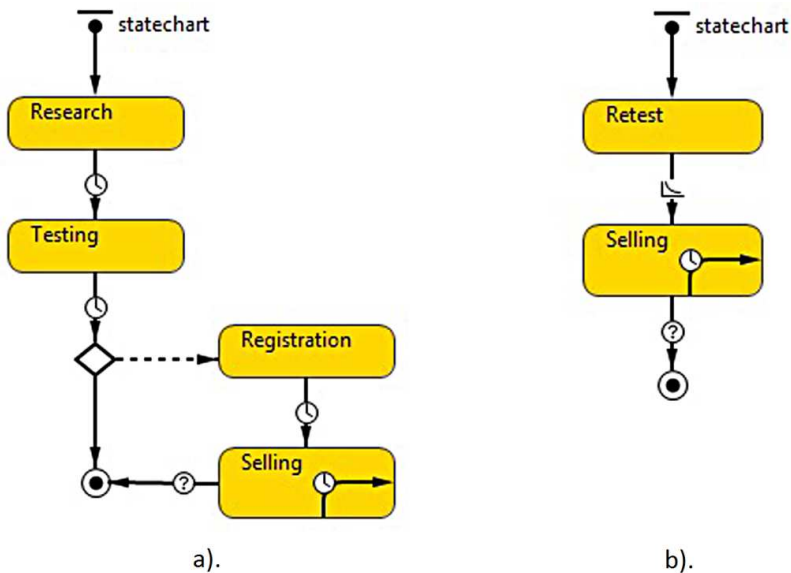
In this figure, the main agent is the user of medicines located in the system in four states:

- Target audience.
- Potential buyers.
- Buyers of original medicines.
- Buyers of generic medicines.

One of the important blocks of the pharmaceutical company's advertising activity module is a block of studies on the stages of the medicines' life cycle. The dynamic changes in the uncertain, stochastic environment are carried out during the simulation, while in most studies on this issue econometric methods, less flexible, are used<sup>177</sup>.

As noted earlier, in the pharmaceutical industry, medicines are clearly divided into original and generic ones. Thus, 2 types of statechart of medical products exist in the model-simulator of pharmaceutical enterprises' advertising activity: original (Figure 8, a) and generic (Figure 8, b).

Figure 8. Statechart of original and generic medicines



Source: compiled by the authors on the basis of the research

The original medicines in the system can be in four states: Research, Testing, Registration and Selling, while generic medicines – only in two: Retest

<sup>177</sup>Sharma, A., Saboo, A.R. & Kumar, V. (2018). Investigating the Influence of Characteristics of the New Product Introduction Process on Firm Value: The Case of the Pharmaceutical Industry. *Journal of Marketing*. – № 82(5). – pp. 66-85.

and Selling. This is due to the fact that the original medicines pass through a complete cycle of preclinical and clinical studies and compulsory registration.

**Conclusions.** With this model of advertising activity, a pharmaceutical company in real time can track customer behavior and the life-cycle of medicines, taking into account the volatility and instability of the pharmaceutical market. Reproduction of stochastic nature of the investigated processes and dynamics of their changes by means of simulation provides a sufficient level of adequacy of the developed model application; increases the reliability of the results. The presence of different types of experiments allows management to get statistical and predictive values in a variety of situations with the possibility of setting specific parameters.

Thus, the use of model-simulators is extending the range of the problem's scope and allows quickly refining the results of forecasts as additional information is received.

The selection of software platforms for the implementation of simulation experiments that provide a sufficient level of data security (in particular, AnyLogic, ARENA) becomes particularly relevant in the context of the adoption of the new information security policy General Data Protection Regulation (GDPR) by the European Community in May 2018. GDPR requirements are extended to a significant part of Ukrainian companies, too. In particular, according to experts, the pharmaceutical industry is one of the first in the list recommended to consider new standards of protection.

The conclusion is confirmed by analysts of the consulting company Criteo<sup>178</sup>, which annually publishes forecasts of market trends for the next year. According to the company, the main trends of digital marketing in 2019 will be follows:

- GDPR continues to improve data protection legislation throughout the world: it is anticipated to develop the newest data protection practices.

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<sup>178</sup>Spielman, M. (2018). Criteo Commerce & Digital Marketing Outlook 2019. Available at: [http://www.criteo.com/ru/wpcontent/uploads/sites/10/2019/02/Criteo\\_2019\\_Trends\\_RU.pdf](http://www.criteo.com/ru/wpcontent/uploads/sites/10/2019/02/Criteo_2019_Trends_RU.pdf).

- Strengthened control over closed platforms: Facebook, Google and Amazon are expected to introduce new technologies for data exchange and privacy protection for users.
- The proportion of video ads in the marketing budget of companies will grow significantly.
- Brands and retailers will unite within an information partnership.
- The use of non-traditional mathematical and technological tools in digital marketing will spread: in particular, the spread of the use of artificial intelligence technologies is predicted.
- Advertising activity will go over into the interior circle of companies: it is expected, that cloud services and artificial intelligence solutions will allow brands to purchase digital advertising directly to the company and refuse to work with agencies.
- The development of voice and visual technologies in marketing will continue.

Increasing the role of advertising and moving it directly to the level of companies will further increase the demand for flexible tools for developing effective advertising strategies. In these conditions, the role of model-simulators will increase even more.

From the given positions presented in this study, the simulation model is quite typical due to open nature and modular architecture. Fragments of experiments carried out on the materials of the leading enterprises of the Ukrainian pharmaceutical industry confirm its effectiveness and adequacy to the current conditions of implementation, which allows recommending the developed model application for wide implementation.