Agent Modeling of Online Store Activities

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Abstract

Agent modeling technologies allow solving the problem of online trading, giving a clear vision of the possible consequences of making management decisions. Analysis of publications and resources has shown that a necessary condition for the development and improvement of the online store is the use of effective data and content management technologies. This area includes such areas as large data management, regional data management, multimedia data management, as well as participation in web mining, data analysis on the Internet, web content modeling, etc. The study of the functioning of the online store gives the ability to choose the optimal market strategy with minimal advertising costs. An agent model has been implemented to study the functioning of structural elements and reflect the processes that occur during the purchase of goods. As a result of the implementation of the model, the level of growth of potential buyers was determined. Agent modeling technologies allows tracking the conditions under which each purchase will be made.

Keywords [1]

E-trade, agent modeling, AnyLogic, online store operations

1. Introduction

The current development of the economy is characterized by a rapid growth of the pace of informatization of economic processes, the expansion of the scale of e-business and, in particular, of retail e-trade on a large scale [1, 2]. Rapid development of e-commerce and online marketing are becoming an attractive alternative to media campaigns because they can be cost effective with a relatively small budget and specifically targeted to user profiles. In recent years [3, 4], electronic trading has grown rapidly, spreading comprehensively and offering an increasingly diverse assortment of goods and services, the e-commerce becomes an instrument for the integration of individuals, enterprises, industries, state institutions and states into a united community, within which the interaction of partners is effectively and unhindered by means of information and telecommunication technologies.

In current environment, e-commerce has significant benefits. Using of Internet communication channels significantly reduces the cost of organization and technical support of the infrastructure, also e-commerce capabilities allow to quickly update business strategies at any moment [5, 6]. The basis of e-commerce is the new information technology for commercial operations and the management of production processes with the use of electronic analysis of large data. Currently, the organizations thanks to the use of e-commerce go to new markets, receive the necessary information about the needs of consumers, react quickly enough to different demand changes, reduce both financial and temporary resources, and increase competitiveness [7, 8].

Therefore, it is important to know buyer and effectively research, analyze data to effectively company management based on data about it, its purchasing power and cost level. The functioning of online trading enterprises in the conditions of a market economy necessitates adapted management,

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planning of a product range that meets the needs of the population and at the same time contributes to the profitability of producers [5, 9].

The problem of modeling of e-commerce processes [9-11] is currently one of the most urgent due to the dynamic growth of this economic activity area, both in terms of trading operations and territorial coverage of potential participants in e-commerce. Given these circumstances, there is a process of analysis of the problem of e-commerce and the use of economic and mathematical tools can be used to study the complex patterns of interaction in e-commerce and serve as framework the development of various management mechanisms.

Modern information technologies of computer simulation make it possible to increase the effectiveness of traditional methods [12, 13]. Agent modeling technologies allow optimizing the current state of the enterprise, and reducing advertising costs. There are two main areas in online advertising [5, 14]:

- branding;
- performance marketing.

The first direction based on attracting customers through the formation of brand knowledge. This approach characterized by creating a link between a particular brand and a group of products, sellers, increasing the number of potential consumers and ensuring brand promotion. The methods of this strategy include tools of Internet marketing: contextual and media advertising, promotions, advertising on social networks. The second approach to Internet marketing based on the needs of small businesses. Performance marketing is aimed at attracting a specific target audience, it is characterized by the use of different methods of online advertising. Such methods include calls, applications, consultations, sales, visits of a specialist or consultant to the client. The direction of performance marketing requires advertising to achieve a specific goal by actively engaging the target audience and constant feedback.

The aim of the study is to construct a model, describes in detail the work of an online store. The main task is the construction of a real object model and its functioning dynamics. Due to the minimal distortion of the structure of the object, the result obtained by simulation is close as it possible to the real ones. The model, compiled correctly, is almost identical to the mapping of a real object with a set of appropriate parameters. Modeling the functioning of the online store should provide the opportunity to choose the optimal market strategy to achieve by a certain point in time, the required number of consumers of the product with minimal costs for their implementation. For this purpose we used AnyLogic computing environment [15].

2. Literature review

A number of studies (e.g., Zhong et al. [16], Llacay et al. [17], Pursky et al. [18], Ravand et al. [19], Oh et al. [20], Dezsi et al. [21]) have researched modeling of business processes in the field of e-commerce.

For example, Zhong et al. [16] in their research found that that steady collaboration between online traders is required quality development of electronic markets. In this study, Zhong et al. explores the processes that underlie the relationship between reputation and the level of cooperation in the light of agent-based modeling.

Author's attempts to establish reputation system based on trust, and analyzes its impact on the sust ainability of mutual cooperation between online sellers, emphasizing such factors as the level of trust of Internet traders and the importance of influencing their past behavior. As noted by the authors [16] the simulation result revealed a relationship between the smoothing constant and the probability of simulation. Average income trader decreases with increasing smoothing constant.

The identified finding shows the main direction to implementation of a trust-based reputation system to develop the sustained cooperation among online traders. At the same time, it should be noted that further research is needed to test the proposed a trust based reputation system in terms of its ability to impact the desired outcomes like sustainability of mutual cooperation between online traders which has not been sufficiently studied in this research.

Llacay et al. [17] in their studies note that the use of agent models has increased in recent years to for studying different social systems, and especially financial markets. According to Llacay et al.,

agent modeling of financial markets are usually validated by checking the ability of the model to reproduce a set of empirical stylised facts. At the same time, the authors note that other common-sense evidence is available which often overlooked, ending with models that are valid but do not make sense.

This paper [17] considers the issue of building an agent model of the stock market, which implements realistic trading strategies based on practical results. Authors test the model in four stages: assessment of face validity, sensitivity analysis, calibration and validation of model outputs.

The studies performed by Pursky et al. [18] present the model for construction of e-trade management system architecture which consists of two basic blocks: the landing Web-pages management unit of the online store is responsible for interacting with the user, receiving orders and collecting primary information and Web-enterprise management unit, responsible for processing orders, their delivery, and all enterprise's business processes realization. Authors focused their attention to developing an architecture model for e-trade management system. A service-oriented architecture (SOA) using enterprise service bus (ESB) concept is offered for architectural implementation. In developed e-trade management system architecture was used the method of integrating complex information systems within the information environment based on SOA and ESB technologies, which represents an independent, integrative subsystem for relatively integrated information systems. Typical information systems that belong to the e-trade system are used as services. These web-based services should be developed and used to enhance ESB efficiency. Such web-services implement SOAP and use WSDL (Web Services Description Language), as well as UDDI specification (Universal Description, Discovery and Integration). At that, as author's note [18], each typical information system is simultaneously data supplier and data consumer. Each information system handles its own data class, while being able to both transmit and receive, adjust and modify data according to operational information from other information systems within main business processes [18].

Other authors Ravand et al. [19] focus on assessing the impact of new technical means on which all modern systems are based, which play a key role in the development of practical systems for companies, especially commercial and trading companies. This paper discusses the issues of the trade process and new tools and instruments for online trading and the impact of technical implementation on the process. First, the authors rethink the basic process for a trading company and then, based on the updated process, propose a new electronic system, taking into account the rules and conditions for the implementation of e-commerce. Then the authors tried to implement a practical block from the point of view of the supplier, using the interaction approach. The next step is the introduction of new electronic tools for redesign, renewal of business relations and implementation of the trade process. In this study, for evaluation of designed model authors [19] tested SIFCO as a trading company for steel materials and analyzed the data as a result of the implementation of the system and studied its performance on the criteria of time and accuracy.

The article named as "A modified innovation model for e-trading systems in South Korean businesses" [20] devoted to explore the adoption, use, and performance of e-trade systems in South Korean businesses. The authors have developed an extended resource-based model to address a performance aspect that is still irrelevant in previous studies. Oh et al. [20], using the new model, 114 businesses showed the relationship between perceived usefulness, apparent ease of use, use of electronic systems, and business efficiency, and analyzed hidden averages to study the moderation effects of high and low efficiency e-commerce systems.

They noted that the effect of changing variables depending on the use of electronic trading systems. As the groups with high and low levels of use, usability impact on reuse and further use also affect performance.

The authors [20] only examined Korean enterprises, so it is advisable to study foreign counterparts in international e-commerce. Authors emphasize that the results obtained are sound for managers and politicians in developing e-commerce system strategies and the context of e-commerce None of the previous studies of advantages, namely convenience and benefit not investigated the relationship between the use and performance of business-oriented e-commerce system Notably, according to the authors [20], further research could explore how to change the dynamics of the sector in overtime mode, and explore opportunities for qualitative approaches to specific research to better understand the perspectives of firms regarding the formation of management strategies and decision making.

Dezsi et al. [21] in their studies indicate that high frequency computer-based trading (HFT) represents a challenging topic nowadays, mainly due to the controversy it creates among investors on the financial market. In this paper [21], authors compares two types of agent models, one with zero-intelligence traders and the other with intelligent traders in order to simulate the tick-by-tick high frequency trades on the stock market for the selected U.S. stocks. Realisations of the agent-based models are done with the help of Adaptive Modeler software application which uses the interaction of 2,000 heterogeneous agents to create a virtual stock market for the selected stock with the scope of forecasting the price.

Within the intelligent agent-based model the population of agents is continuously adapting and evolving by using genetic programming in forming new agents by using the trading strategies of the best performing agents and replacing the worst performing agents in a process called breeding, while the zero-intelligence agent based model does not evolve, agents do not breed, and they trade in a random manner. And they, comparing the compliance of the two models with real data, claim that the results show in almost all cases that the intelligent agent model works much better than the model based on the agent with zero intelligence, which can be regarded as lower market efficiency, which allows to predict stock market price or even manipulate the stock market. Also, the zero-intelligent agent-based model generates more trades and lower wealth for the population, compared to the intelligent agent-based model.

Based on their research, the authors [21] formulated the next conclusion: the high-frequency data turns out to be very hard to simulate and analyses due to its particularities which differentiate them from daily data, as price changes are discrete, being multiples of the minimum price increment, the price changes not being independent.

The review of literature indicates the most of the studies are quite exploratory in nature where reviewed existing approaches and proposed directions for future research. Due to the above-said reasons, this research motivated us towards developing an agent model to study the functioning and reflect the business processes that occur during the purchase of goods in online store. Unlike the others, the stage-by-stage technology of building an agent model that presented in this article takes into account features of e-trade business processes and can be considered as typical for creation e-trade management system of most online store.

3. Results and discussion

For fast tracking and responding to changes in the market, and to image dynamics increase the number of customers, it is advisable to use agent modeling technologies. The first step in building a model will be to determine the criteria and conditions under which the experiment will begin. A relatively small market with 5,000 people will be considered. To implement the model, each client will be an agent. Since it is determined that the conditional company is new, no one will be interested in the product at first, people's interest will appear under the influence of advertising. After that, the number of successful sales will be affected by the natural increase in customers, which will occur due to the fact that customers who have already bought the product will share information with their friends. The last to the model will be added indicators that can negatively affect the operation of the system, as they will change the conditions under which each purchase will be made.

The block scheme of the online store is very simple, step by step it can be described as follows (Figure 1):

- buyer goes to the website of the online store, looks for the product and sends it to the cart when placing an order;
- client indicates his contact details and method of payment;
- manager contacts the client to confirm the order and clarify contact information, delivery point;
- customer pays for the order at this stage, or does so upon arrival of the goods; the manager of the online store, or another employee, packs the goods and sends it by courier service (if the customer did not prefer self-pickup);
- customer receives the order and makes the payment if he has not done so before
- after-sales interaction with the buyer (cross-sell, up-sell, advertising and email-marketing).

Potential buyer visits the online store, registers, places the selected order and:

1) the goods are delivered to the warehouse
2) collection of the order in a warehouse
3) change the status of the order in the database to the current state at the time
4) registration of documents to the order (check) and notification to the client about readiness

The process of building an agent model consists of successive steps.

Step 0. *Analysis of the initial data*. Identify key model variables and create a flowchart of the model. When creating a flowchart, it is taken into account which variables should be represented by drives, which by flows, and which by dynamic variables.

Step 1. *Create a new model*. The model is organized hierarchically and displayed as a tree: the model itself forms the upper level of the tree; experiments, agent types, and Java classes form the next level; elements that are part of the agents, embedded in the corresponding branch of the type of agent, etc.

Step 2. *Creating drives*.

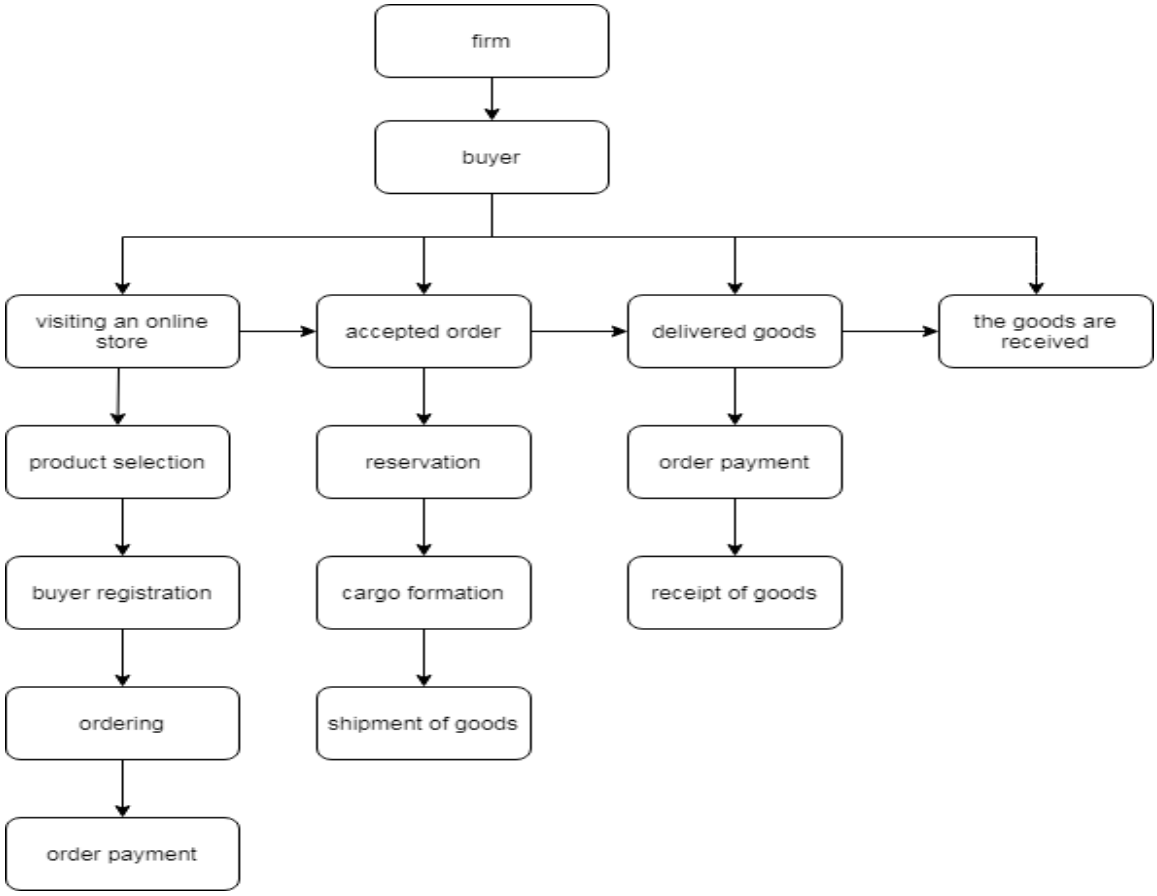

Figure 1: Block diagram of the operation of an online store

Step 3. *Add a product sales stream*. After creation in model the two drives modeling numbers of potential consumers, and consumers of a product it is necessary to put streams. There will be only one flow in the model - the product sales flow, which increases the number of consumers of the product and reduces the number of potential consumers. In AnyLogic [15], the flow is specified by the variable “flow”.

Step 4. *Adding constants*. The frequency with which potential consumers communicate with consumers will be a constant in the model. Let each person make an order with an average of 200 people a year.

Step 5. *Setting the initial values of drives*. After establishing the connection, you can set the initial value of the drive. The initial value of the “Buyers” drive, which simulates the product for the

consumer, does not need to be set, because initially the number of consumers is zero, and the default drive and so is initialized to zero.

Step 6. *Creating dynamic variables*. In the case of compiling the expression of the initial value of the drive, any variable is involved in the formula of a dynamic variable or flow, there must be a relationship between these variables (Figure 2).

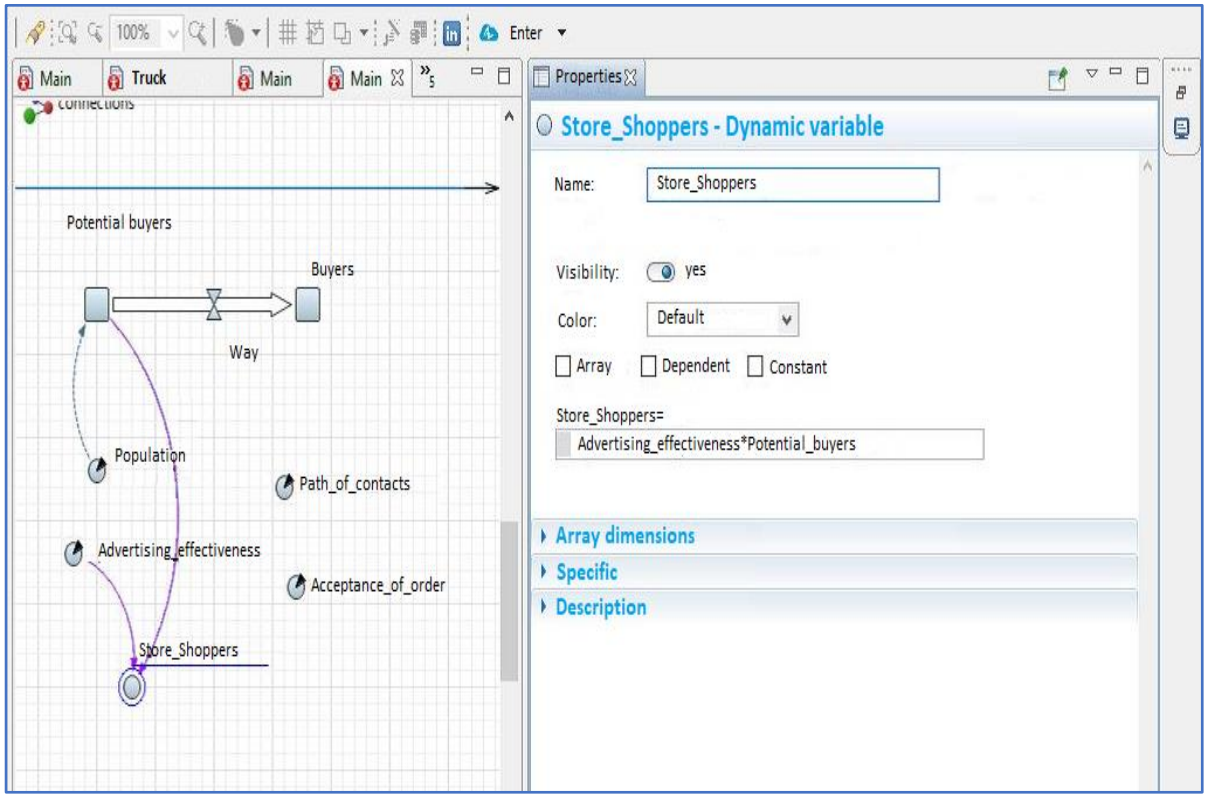

Figure 2: Specify relationships between dynamic variables

The number of people who own the product and can persuade others to buy it, in this model at any given time will be determined by the value of the drive Buyers, and each consumer will communicate per unit time with the flow of people, the number of contacts per unit time of all consumers will be equal to Buyers * Stream.

The model must take into account that the manager's conversation with a potential buyer may end inefficiently. Therefore, it is advisable to add another factor - Order Acceptance, which determines the strength of persuasion of product owners, and determines the proportion of contacts that leads to product sales.

It is also necessary to take into account in the formula the probability that those with whom the consumer communicated are not yet interested in the product. This probability is set as follows: Potential buyers / Population.

So, the formula will look like this: Buyers * Stream * Order Acceptance * Potential Buyers / Population

Step 7. *Configure model startup*.

Before running the model it is needed must select the mode of its execution. The AnyLogic model can be executed either in virtual mode or in real time. In virtual time mode, model made without reference to physical time - it is simply executed as fast as possible (Figure 3). This mode is best suited when it's necessary to simulate the system for a fairly long period of time. In real time, the relationship of model time with physical, the number of units of model time performed in one second.

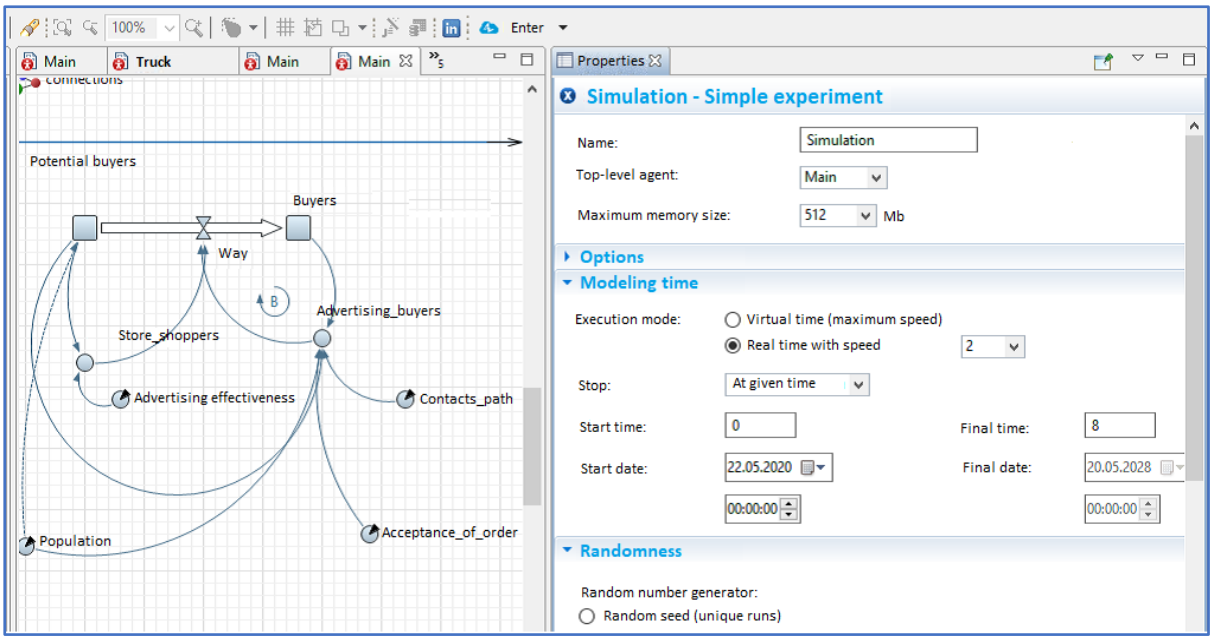

Figure 3: Model startup settings

Step 8. *Launch the model*. After starting the model, its current value will be displayed next to each element (Figure 4).

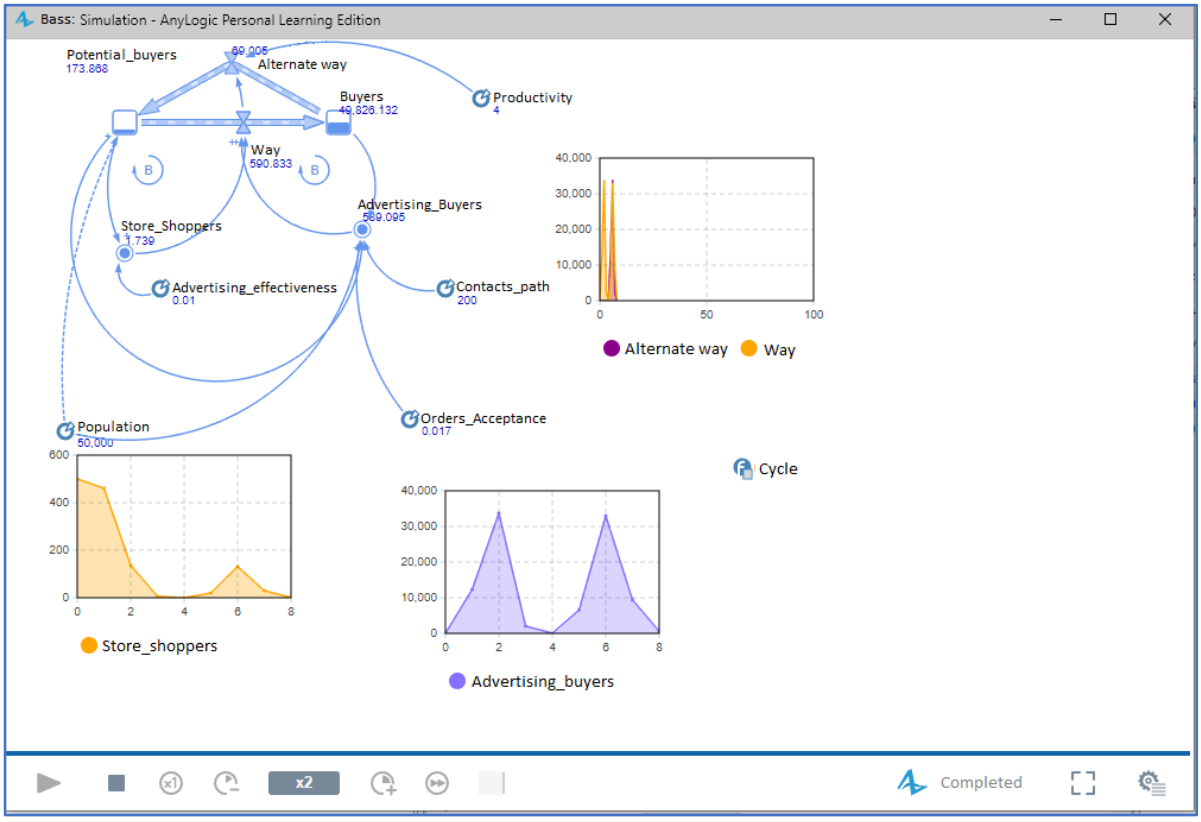

Figure 4: Execution of the model

Step 9. *Add charts*. AnyLogic supports various tools [15] for collecting, displaying and analyzing data during model execution (Figure 5).

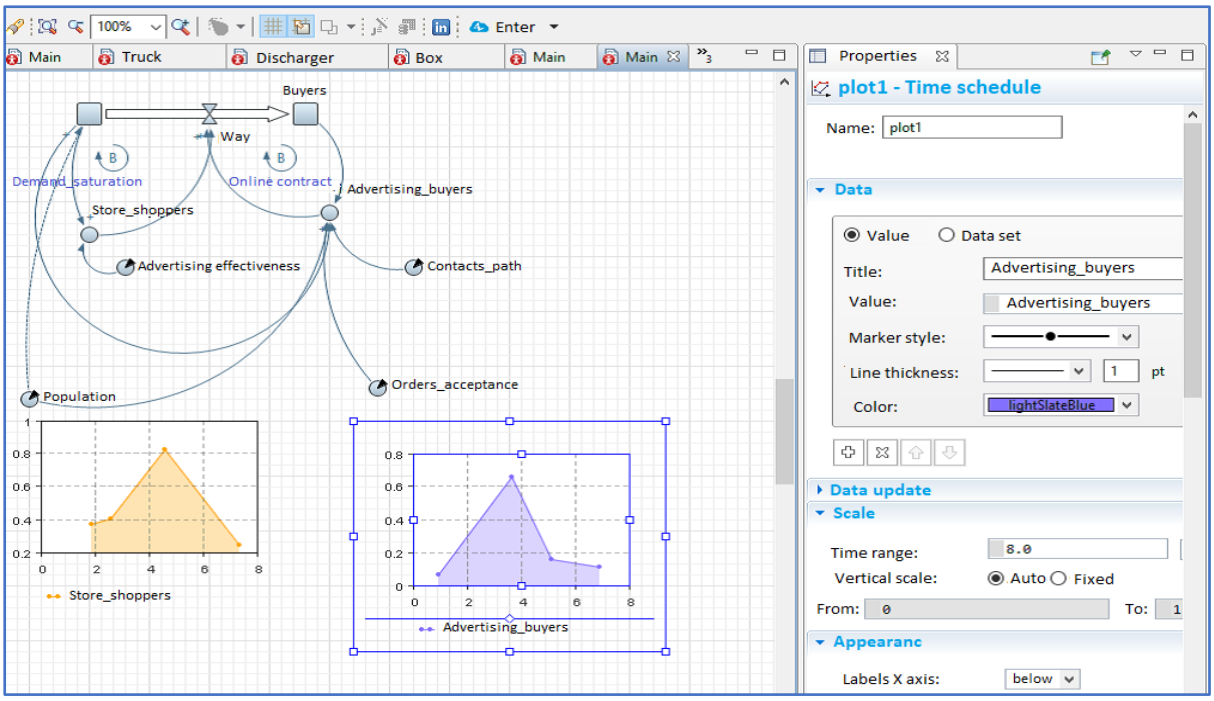

Figure 5: Dynamics of changes in the number of consumers

In this model, the number of potential consumers is not reduced to zero, but is constantly replenished as consumers re-buy products instead of unusable ones. The intensity of product acquisition increases, decreases, and eventually takes on a value depending on the average suitability of the product and the parameters that determine the intensity of this flow. The presence of a product in the withdrawal model means that some part of the population will always remain potential consumers (Figure 6, 7).

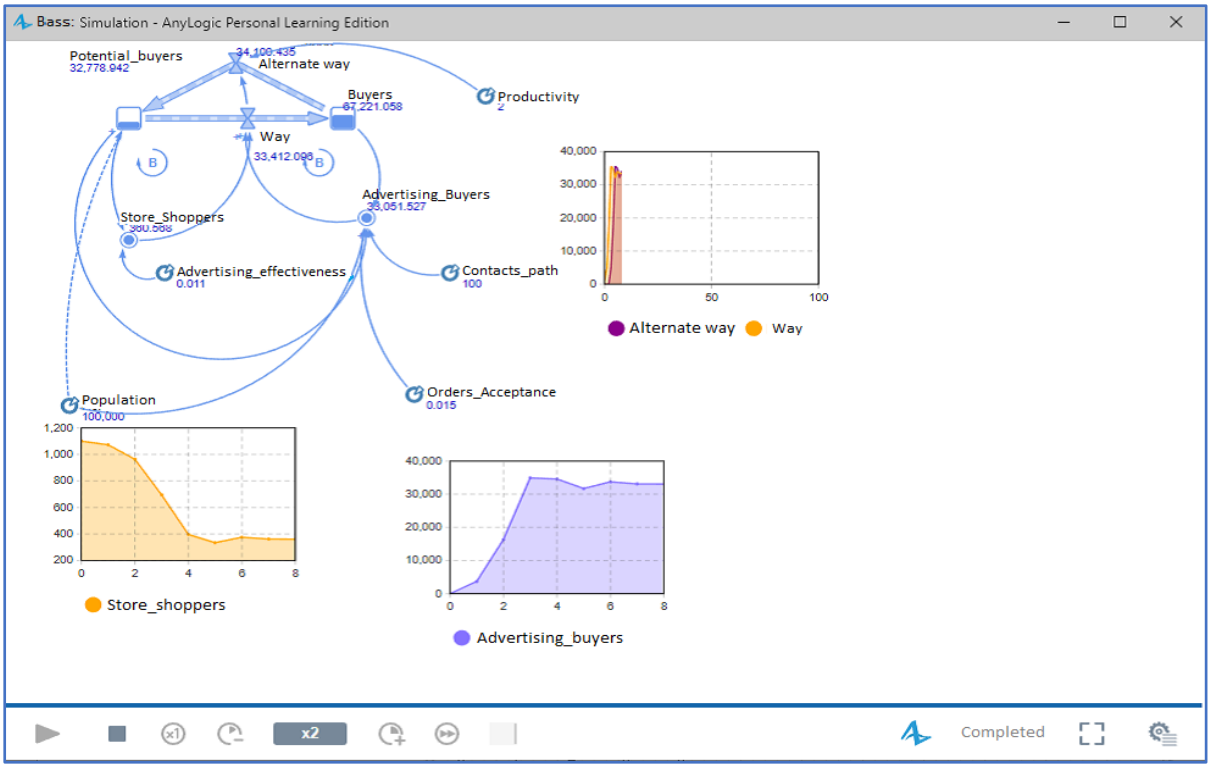

Figure 6: Intensity of the flow of buyers

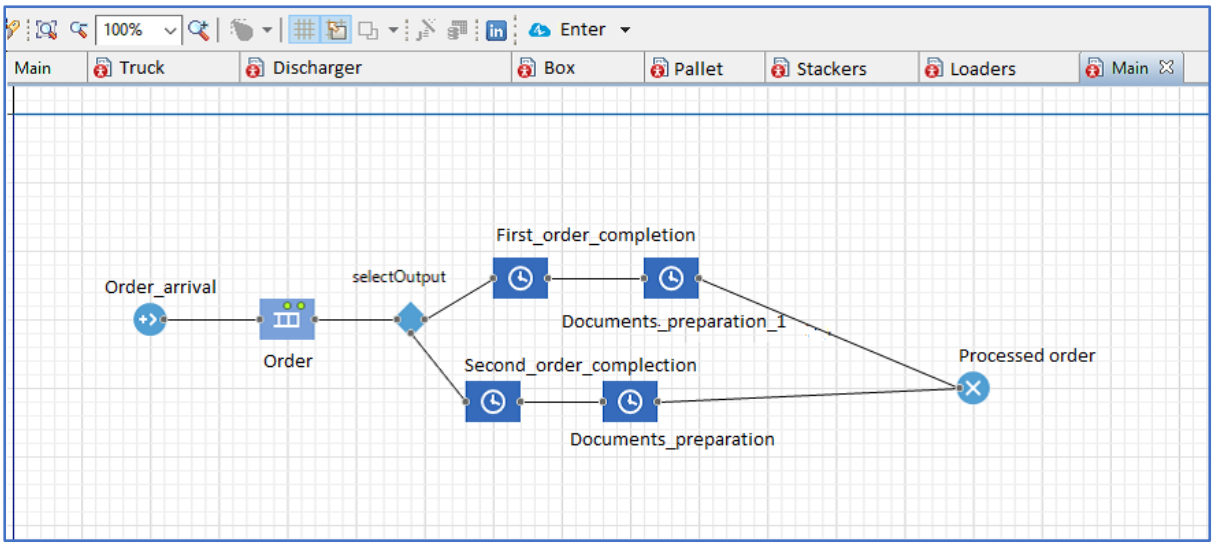

Figure 7: Process of functioning of the online store

The most effective option for an online store is one in which the time to collect the order is minimal. This version of the process reduces the time to search for goods in the warehouse and increases the quality of service. In most cases, such goods do not require mandatory personal inspection by the buyer before the latter decides to purchase. Therefore, the number of customers only increases over time, and hence increases the burden on employees.

4. Conclusion

Agent technologies in e-commerce are quite appropriate today. Simulation modeling technologies expedient to use in research to increase the effectiveness of traditional methods. Agent modeling concept allows to assess and optimize the current state of the enterprise to reduce advertising costs using the created model. According to the obtained simulation results, the most effective option for the online store is one in which the time to collect the order is minimal. This version of the process reduces the time to search for goods in the warehouse and increases the quality of service. In most cases, such goods do not require mandatory personal inspection by the buyer before the latter decides to purchase. Therefore, the number of customers only increases over time, and hence increases the burden on employees. Thus, agent modeling technology makes it possible to conduct preliminary modeling of any enterprise in e-commerce to ensure the possibility of choosing the optimal market strategy and the required number of consumers of the product with minimal costs for their implementation.

5. Acknowledgements

This study was supported by the Ukrainian Ministry of Education and Science, Project No. 0117U000507, “Modeling the mechanisms of international e-commerce operation”.

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