Simulation of the Impact of Social Media on Promoting Education Services

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Abstract. The role of education services in the global competitiveness of Ukraine was shown. A specific of educational services, educational services market structure and characteristics of its subjects was reviewed. Analysis of survey results on the effect of different channels of knowledge enrollees on the university was held. The advantage of impact the social of the channel from the inner circle of enrollees, namely parents, friends, classmates was shown. Bass model parameters for the purpose of educational services, simulation of the dynamics of the spread of information among universities AnyLogic is made.

Keywords. Educational services, higher education institution (HEI), social media, Bass model, Agent based modeling, AnyLogic

Key Terms. Academia, MathematicalModel, Simulation, AgentBasedSystem

1 Introduction

Ukraine is deeply integrated into the world community. As the global financial crisis deepens, so it affects Ukraine. It challenges all spheres of socio-political and economic life, and the education sector can't be an exception. The level of educational services is one of the important indicators of country's competitiveness.

Education is a process of learning, teaching. In a broad sense, education is the product of the formation of intelligence, character and physical abilities of the individual. The society is purposefully transmitting accumulated knowledge, values and skills through education by certain institutions: schools, colleges, universities and other institutions. Higher education is the highest level of professional education, following the general secondary and vocational education. It includes a set of systematized knowledge and practical skills that can solve the theoretical and practical problems of the professional profile, using and creatively developing the modern achievements of science, technology and culture.

Global competitiveness ranking "The Global Competitiveness Report 2015–2016" was presented at the International Economic Forum in Davos. Global Competitiveness Index is a global study, which accompanied by country ranking in terms of eco-

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nomic competitiveness. This index is calculated according to the methodology of the World Economic Forum "Word Economic Forum". According to this rating by one of the strengths of Ukraine is education and innovations [16].

The place of Ukraine in the field of educational services from 140 countries:

- primary school enrollment – 45th place;
- secondary education enrollment – 33rd place;
- higher education enrollment – 14th place;
- quality mastering math and science – 38th place;
- Internet access in schools – 44th place.

Innovations are the result of educational services. Ukraine takes the following positions in this area:

- the quality of scientific research institutions – 43rd place;
- availability of scientists and engineers – 29th place;
- the number of registered patents (intellectual property rights) – 50th place.

So education is one of the few spheres in which our country takes a worthy place in the world ranking. Therefore, positive transformation in this area is one of the key aspects to overcome the economic crisis and forming a positive presentation of the country and its European integration [6].

The Market for education services is socially important. This market was formed in the country on the post-Soviet territory. Therefore, the process of market relations formation is quite complex and sometimes have spontaneous and uncontrollable character.

Under market conditions, the essence of relationships between the citizen and the state is changed. Education becomes the sphere of educational services. The citizen as the taxpayer is entitled customer and requires improved quality of educational services, taking into account the needs of enrollees and their parents.

The aim of this paper is to build and test a dynamic model of information dissemination on HEIs as a tool to attract students. For achievement of aim it is necessary:

- to consider and to describe the structure of the education market;
- to analyze the impact of various information channels to choose from enrollees in Ukraine;
- to explore the dynamics of the spread of information among university enrollees in social networks.

2 Features of the Education Market

In recent years, the close integration is between Ukraine and the EU. It is naturally reflected in the educational relations. Today 15% of the students leave Ukraine to study abroad. Every year the competition increases in the education area. So now it is needed to use all available tools to promote higher education institutions and their services to attract new students.

Educational service is a specific product, characterized by its features. Educational services are services that develop and improve the consumer. In generally there is not plenty of such services, for instance: medical, cosmetic etc. Besides, educational services are characterized by complex influence on various aspects of a person's behavior.

In the education market, there are producers, consumers and intermediaries. The specificity of the educational market has four types of subjects:

- consumers – graduates, students who directly receive educational services;
- customers – parents who pay for educational services and influence the choice of educational institution;
- customers – employers who are interested in upgrading and further training of personnel, and who pay for staff training;
- customer and consumer – a state that guarantees the quality of education and is interested in the formation of skilled labor.

The main subjects of this market are: the consumer – enrollee or student and producer – school. Each subject has its own specific interests: student – tends to get a certain level of knowledge that will allow them to take a worthy place in the labor market; school – offers such educational services that are competitive in the market. The state should create such legislative conditions in education in general, to ensure the competitive growth of highly skilled professionals, and to improve the quality of human capital.

The education market is also inherent in the competition. But educational services have the peculiarity.

The first, the customer is the main subject of choice. It can be parents of students, but not the students themselves. First of all, this aspect affects the target audience advertising of HEI.

Second, to promote educational services the HEI cannot offer all traditional marketing strategies. This service has specificity. Offered intellectual product to consumers does not guarantee that received education will bring the expected results. But the promotion of educational services in market conditions is necessary, because a successful marketing strategy helps to attract more students, increase competitiveness and give more opportunities to attract the best students.

3 Analysis of the Impact of Social Channels on Decision Making to Choosing a Higher Education Institution

So to attract specific educational services consumer we must find what is influences the enrollee in choosing higher education institution, what sources of information are most authoritative. For this purpose two surveys in social networks was administered. This format was chosen because, the first, social networks offered convenient tools for carrying out such surveys. Second, complete anonymity is ensured. This is the necessary psychological factor that allows giving unbiased answers to questions. Respondents who know what his answer will be anonymously rather answer the question

truthfully, even if he inwardly doesn't like his answer. Third, students are a very active audience in social media, and they are interested in obtaining objective information on the channels that are most popular.

The marketing strategy of promoting educational services has many channels of communication that influences the decision on the choice of higher education institute. To determine the preferences of enrollees concerning these channels the survey was carried out on social networks. Questions in the questionnaire were set so as to identify from which most enrollees receive information about the university.

The survey was addressed directly to the enrollees. So could find out how to enhance the effectiveness of certain areas in the promotional campaign. But also to understand most effective directional distribution way of advertising among students and their parents is needed to maximize efficiency.

This question was asked in the questionnaire: "How did you know about our university?" The following answers were given:

- from classmates, parents or friends;
- from ad campaign of the University (open day, University presentation at school , printed advertising materials);
- from friends in social networks;
- advertising on social networks;
- official website of the University.

Two surveys were carried out: in the urban social network (Kharkiv) and in the social network at the Web-page group of University department related to IT.

The first survey was carried out to get information for the overall situation of the city in general. The survey was carried out at the end of May, when the future enrollees generally have not yet made up their minds. Outcomes of the responses were grouped as follows (Fig. 1):

- Group 1 – "Parents, Classmates, or Friends" – answering options: from classmates, parents or friends; from friends in social networks;
- Group 2 – "Advertising of Universities" – answering options: ad campaign of University (open day, presentation of the University at school, print advertising materials); advertising on social networks;
- Group 3 – "Universities web sites" – answering options: the website of the university.

About 2 thousand of respondents took part in the survey. Such a number of respondents were made possible by the high popularity of social groups mainly among younger audiences: high school students, college students, graduates and working people who recently graduated from high school. The answers were distributed as follows. More than two-thirds of respondents received information and feedback from friends, classmates and parents. Other answers almost evenly distributed between the other two groups of sources.

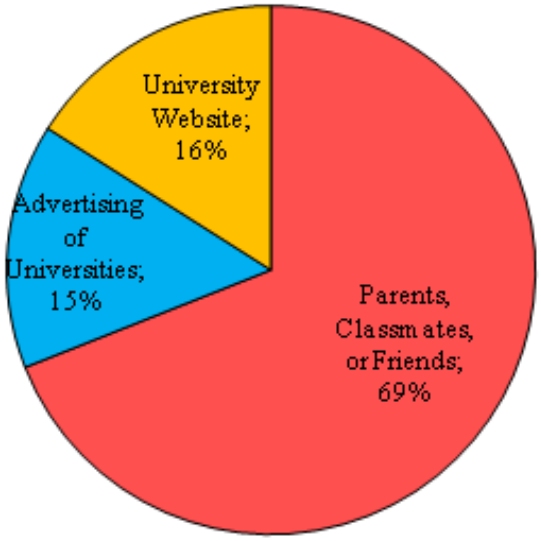

Fig. 1. Distribution of channels in the survey in the social network of the city

It is not an accident that social groups organized the way where friends in a network are in the first position among the list of group members, then – friends of friends (acquaintances), and so on. Considering the significant number of respondents, we must recognize that social channel influences final decision in a greatest way. The vast majority of successful marketing strategies in promoting various products and services have been actively using these channels for a long time. Promotion got popularity as through the traditional social channels and also Internet social networks lately. [15, 19].

The second survey was published in the social network of the University department group which provides education in IT (Fig. 2). As we see in this survey the overwhelming majority of respondents gave preference to the social channel from the inner circle (48%). A feature of this audience is its focus on the IT sector; therefore, a higher percentage was obtained for the advertising through the site university (20%). Also, among this audience, a large number of enrollees were previously motivated to go this university through the professionally-oriented institutions work. Therefore, this channel has obtained more than twice higher percentage of answers than traditional advertising of universities. As we see in this survey the overwhelming majority of respondents gave their preferences to the social channel from the inner circle (48%). A feature of this audience is in its focus on the IT sector; therefore, a higher percentage was obtained for the advertising through the site university (20%). Also, among this audience, a large number of enrollees were previously motivated to go to this university through the professionally-oriented institutions work. Therefore, this

channel has obtained more than twice higher percentage of answers than traditional advertising of universities.

The difference between those two surveys may indicate following. When enrollee chooses the professions related to IT sphere, he relies largely on his own experience, and on his idea of what he wants to achieve in the future.

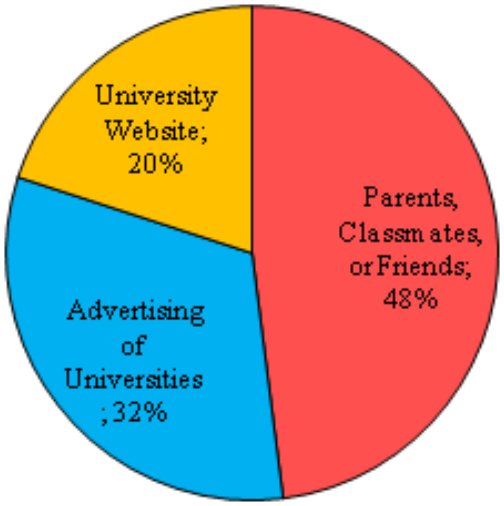

Fig. 2. Distribution of channels in the survey in the social network of the University Department group

Social channel "Advice of family and friends" is important for the enrollee in both surveys. This channel belongs to the personal channels (direct) communication. Promoting educational institution and its services may be performed through university teachers and students meetings with school graduates and their parents, as well as open door days, summer schools, competitions, work in small academies and more.

4 Simulation of Dissemination of Information on HEI among Students

4.1 Agent-Based Modeling as a Method to Study Consumer Behavior

An important task of promoting educational services is to analyze the impact of dissemination of information on HEIs up to enrollees. Simulation modeling methods are widely used to carry out this analysis. Simulation is a method for Applied Systems Analysis, which is a powerful research tool of complex systems and processes, including those associated with making decisions under uncertainty. In comparison with other methods simulation modeling allows us to review a large number of alter-

natives in order to improve the quality of management decisions and to make more accurate predictions of their effects.

Agent-based modeling is a method of simulation modeling, which examines the behavior of decentralized agents and how such behavior determines the behavior of the system as a whole. When developing agent model, parameters of agents are entered, defined their behavior, put them in a certain environment, established possible links, and then ran the simulation. The parameters of agents may be people, such enrollees. The individual behavior of each agent creates a global behavior of the simulated system. The main feature of the agents is the possibility of taking independent decisions, due to the active role of agents in the model.

In practical terms, agents must have certain characteristics [13]:

- the agent is identified. It is the essence with the set of characteristics and rules that governs its behavior and decision-making capabilities;
- the agent is autonomous. The agent has a border and can be easily identified, that is part the agent, and that is not part of the agent;
- the agent is in an environment where it interacts with other agents. Agents have protocols for communication with other agents, and the ability to respond to the environment;
- the agent must be purposefully based on the logic of their behavior. This allows the agent to compare the results of their behavior towards their goals;
- the agent is autonomous and independent. The agent can independently function in their environment and in their relations with other agents, at least in a limited range of situations;
- the agent is flexible, It has learning ability and adapts its behavior based on experience. It requires some form of memory;
- the agent may have rules that change their own rules of conduct.

On this basis agent can be formally presented as it is in Fig. 3:

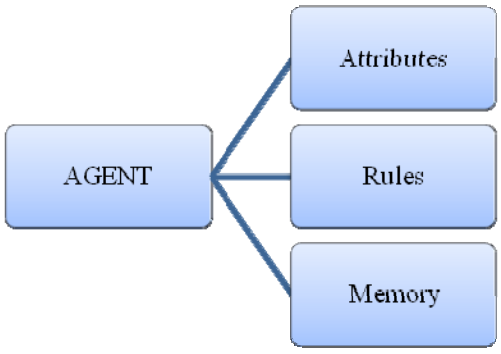

Fig. 3. Formal presentation agent

In a dynamic, competitive and complex market environment the choice of customers often depends on the individual, congenital activity of consumer, networking, and

external influences. This is best described by using agent-based modeling. Agent-based modeling will help to highlight and simulate processes in social networks and various contacts between people. As a result, objective information distribution forecasts will be obtained.

4.2 Bass Model to Determine the Dynamics of Dissemination of Information on HEI among University Enrollees

Bass model describes the process of dissemination of the product (service) when the product (service) is unknown for buyer at first. Then the product is advertised to start selling. [2–5]. As a result, a certain share of people will buy the product under the influence of advertising. This category of people is called "innovators". Others can buy the product only under the influence of communication with other people who already bought this product. This category is called "imitators". The process of purchasing of a new product under the influence and conviction of people who already bought it something is like an epidemic. The probability of acceptance of the idea of those who have not accepted is a linear function of those who previously accepted idea. [2].

To make the laws a reality it is necessary to have absolute interest in product of the entire tested audience. How quickly innovation is spread depends on how quickly and from which sources audience will get information about it. We should also keep in mind the trust factor in advertising and general psychological characteristics of customers and their groups. Some will be more likely to try new product under the influence of advertising, others will make any decisions only when they saw the experience of friends or colleagues.

The formal description of this model is.

$$\frac{f(t)}{1-F(t)} = p + q \cdot A(t) \tag{1}$$

where $f(t)$ - the rate of change of set basic fractions, $F(t)$ is a basic fraction; p, and q – constant, reflecting the influence through advertising and through society; $A(t)$ – a cumulative function of the number of followers (adopters).

The parameter p does not depends on the number of followers $A(t)$, It is therefore called "coefficient of innovation". The parameter q is influence factor on the number of followers $A(t)$. Therefore, we can clearly define its role as a "coefficient of imitation", factor increasing the number of new followers influenced by of the old followers.

Later, instead of the constant q was introduced constant m, which displays the potential market size. In this case, the equation will work much more accurately. Thus, the Bass model has become as follows.

$$\frac{f(t)}{1-F(t)} = p + \frac{q}{m} \cdot A(t) \tag{2}$$

While working on his idea Bass oftentimes changed and improved mathematical reflection of its concept. But despite the fact that the formula was repeatedly redesigned by him, and then was greatly expanded by his followers, the main idea remained in its original form. It is only more confirms author's deep and accurate understanding of marketing processes.

Currently, the most popular is the following formula:

$$F(t) = \frac{1 - e^{(-(p+q)t)}}{1 - \frac{q}{p} \cdot e^{(-(p+q)t)}} \tag{3}$$

Equation (3) allows getting graphic representation of the function. The function that displays the cumulative number of followers is more informative. It is get the following:

$$A(t) = m \cdot F(t) \tag{4}$$

We take a higher education institution as a service provider and the enrollee as a customer. Dissemination of information is carried out at each of the university admission campaigns and can be attributed to the processes described by Bass.

All of the features of the process are:

the audience of potential customers (enrollees) interested in using the learning service of higher education. Not interested, it is rather an exception to the rule and not a trend;

in the final phase, all enrollees who make their choice based on available information;

the choice of the institution is the defining event for life, so just advertising or open days at universities is not sufficient a of information for making decision by enrollees. They are also highly affected by the reviews of friends, advises of elders, and even user discussions on the forums and social networks.

So, we conclude that the Bass classical model is acceptable for analytical description of this process, and can be used for simulation of the behavior of enrollees on choosing HEIs.

4.3 Defining the Parameters of Base Model Based on Statistical Data

Bass model is widely used to predict the spread of new products and technologies. [7, 14] In this paper we propose to use this model for specific products that are educational services. Parameters of external and internal influence significantly affect on the results of the Bass model. In order to use the model we must first define its basic parameters: m , p , and q . Full enough analysis of methods is given in [2–5]. So, to determine the parameters of external (innovation) and internal (imitation) impact of p and q , there is four most convenient methods: Based on the conventional method of least squares (the ordinary least squares – OLS); based on nonlinear least squares method (the nonlinear least squares – NLS); based on

maximum likelihood (the maximum likelihood estimation – MLE); based on the algebraic method (the algebraic estimation – AE). The ordinary method of least squares is the most simple and effective if there are statistics. The main advantage of OLS–assessment procedure is the ease of implementation. The necessary changes needed to conduct Bass equation are shown below. Bass formula will present in the following form:

$$P(t) = p + \frac{q}{m} N(t-1) \tag{5}$$

where N – the cumulative function of followers, P – a probability of acceptance of ideas in the time interval $(t-1;\ t)$.

If the number of not followers at time $(t-1)$ is $(m - N(t-1))$, then the expected number of followers in the interval ($t-1;\ t$) can be marked by $X(t)$ and formula is rewritten as follows:

$$X(t) = pm + (q-p)\,N(t-1) - \frac{q}{m} N^2(t-1) \tag{6}$$

If in function (6) replace some constants related to the equation, we can get the next function:

$$X(t) = a_1 + a_2\,N(t-1) + a_3\,N^2(t-1) \tag{7}$$

The resulting function is well suited for use the least squares method to calculate the coefficient functions. When a_1, a_2 and a_3 are obtained parameters, p and q can be easily obtained as follows:

$$p = \frac{a_1}{m} \tag{8}$$

$$q = -m\,a_3 \tag{9}$$

To determine p and q we will use data from a survey which was held in a popular group of social network. Seasonality, which adversely affects the accuracy of the results, was removed from empirical data. Then time series was created.

Table 1. The survey results

t	$N(t)$	$X(t)$
0	610	–
1	1352	742
2	1622	270
3	1704	82
4	1774	70

t	$N(t)$	$X(t)$
5	1805	31
6	1842	37
7	1848	6
8	1861	13
9	1865	4
10	1857	2
11	1868	1
12	1869	1
13	1869	0
14	1869	0

Calculation of model parameters is performed by mathematical package Math-CAD:

$$count := 15$$

$$G(n,a) := a_0 + a_1 n + a_2 n^2$$

$$\Phi(a) := \sum_{t=0}^{count-1} (X_t - G(N_t, a))^2$$

$$a_0 := \begin{pmatrix} 0 \\ 0 \\ 0 \end{pmatrix}, \qquad a_1 := Minimize(\Phi, a_0) \qquad (10)$$

$$a_1 = \begin{pmatrix} 211.654 \\ 0.836 \\ -5.165 \times 10^{-4} \end{pmatrix}, \qquad R := X - G(N, a_1)$$

$$p = 0.113$$

$$p := \frac{a_{1_0}}{m},$$

$$q := -m \cdot a_{1_2},$$

The obtained p and q themselves confirm the results of the survey. We see a great influence of internal factors (parameter q), and little impact of external factors (parameter p). This completely coincides with the results. Consequently chosen method gave a fairly accurate result of the model parameters. Now they can be used to customize the model and its further exploitation.

4.4 Simulation of Information Dissemination in the Environment AnyLogic

AnyLogic provides a wide range of modeling tools, and has many specialized modules devoted to specific methods and approaches. Especially for the needs of agent-based modeling AnyLogic there is the appropriate ways to create specialized models, as well, as broad information support. Full documentation is provided [10, 17, 18].

The first step in creating the agent model is to determine the parameters of agents who will take part in the simulation and the environment where they are located. The class name is Enrollee. Agents can inhabit in various types of spaces (environments): two-dimensional continuous, two-dimensional discrete and geospatial (GIS).

GIS space allows placing agents in the geospatial environment by using this card. [12]. Continuous space gives us ability to change the location of the agent and receive information about its current location, move the agent with a given speed from one place to another, perform actions on his arrival at the destination, display an animation (static or moving) of agent, make connections under the template of agent's locations, etc. Part of the functionality of continuous space does not even require agents to belong to explicitly given for environment. If the environment is not specified, so then, by default, that space will be continuous. But if agents belong to the environment, the type of space must be defined clearly.

Two-dimensional discrete space is a rectangular array of cells, fully or partially occupied by agents. One cell may contain no more than one agent. Support for this type of space in AnyLogic includes the possibility of distribution agents on the cells, their movement to neighboring or any other cell, determination that agents are neighbors (according to the chosen model of neighborhood), determination of free cell etc.

To simulate the interaction of subjects the educational market will use continuous space. The communications networks between agents in this area may be the following types:

random ($Agent.NETWORK_{RANDOM}$) – Agents randomly connected with a given average number of connections to the agent;

based on the distance ($Agent.NETWORK_{ALL_{IN_{RANGE}}}$) – any two agents are connected if the distance between them is less than a specified maximum;

ring ($Agent.NETWORK_{RING\square LATTICE}$) – connection of agents forms a ring, where the agent is connected with a given number of closest agents;

small world ($Agent.NETWORK_{SMALL_{WORLD}}$) – can be viewed as a ring where some links were "re-made" for agents located far from each other;

scale free ($Agent.NETWORK_{SCALE_{FREE}}$) – some agents are "hubs" with lots of connections and some of them have only a few connections.

The analysis of the nature of relations in social networks was carried out [1, 11, 12]. It showed that in the case of educational services it is better to use network-based distance. The distance, in this case, is a mechanism for modeling the realest and very complex nature of connections between enrollees themselves and their "friends" on the network.

The next step is to determine behavior of agents (algorithm of actions). In AnyLogic, this is possible with the help of creating Java code or by creating an algorithm by using visual elements of Statechart panel. This panel allows you to create an algorithm of actions of the agent by using the agent transitions between states.

The agent will have three states:

$NotInformed$ – the enrollee has not received information about HEI;

$Informed$ – the enrollee received information about HEI;

$Decided$ – the enrollee who submitted the original documents to the HEI.

To implement the Bass diffusion model, we must add the appropriate transitions between states. Three variables are added:

$AdEffectiveness$ – coefficient of external impact, $p = 0{,}113$;

$ContactRate$ – the average number of contacts of the agent with the environment ($ContactRate = 15$);

$AdoptionFaction$ – coefficient of internal impact, $q = 0{,}966$.

Now, we create transitions between states, according to Bass diffusion model. The transition to a state of "Informed" will be done in two ways: through external and internal impact.

Transition Ad simulates the dissemination of information through outside influence, i.e. advertising, media, and so on. Transition is parameter p .

Transition $Interaction$ simulates disseminating of information through internal impact, i.e. acquaintances, friends, parents, and others. It is realized through the third transition in a state of "Informed", and it is named "IntMsg" (Interaction Message), and it works according to the expression $ContactRate \cdot AdoptionFaction$.

As a result of the simulation model with a population of 700 agents was derived curves that are characteristic of the Bass diffuse model.

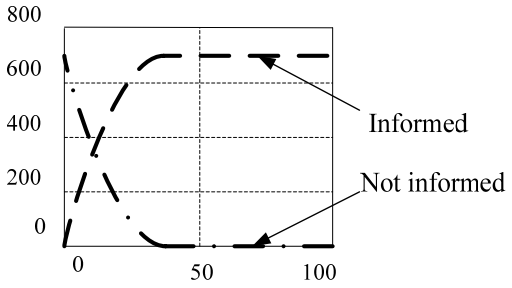

Fig. 4. Agents dynamics chart: two state

Now, we create a transition to the third state of agent by entering additional variable $DecisionReady$ and appropriate transition.

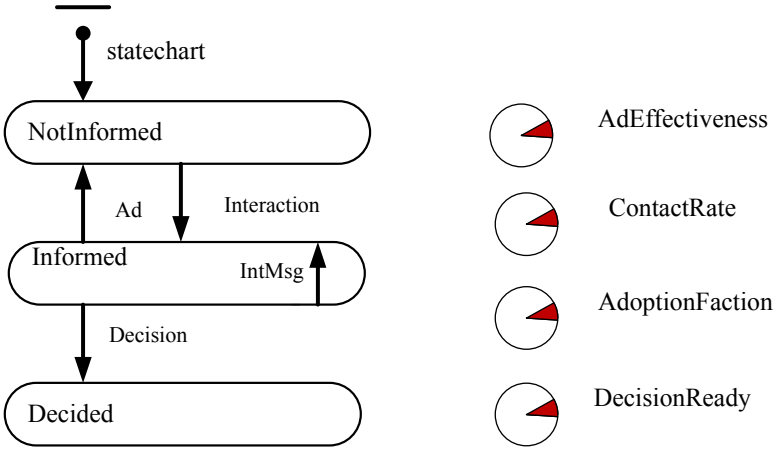

Fig. 5. The final model in AnyLogic

When we are performing a model with a population of 700 we can see three phases of behavior of agents, three changes of state: first, the lack of information, next, review of the options of available actions, and after that, making a decision by the agent according to available information (Fig. 6).

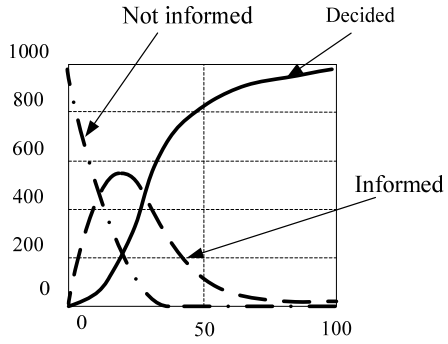

Fig. 6. Agents dynamics chart: three state

The chart shows the time when "Informed" curve is at maximum – this is a period of time with maximum uncertainty in making a decision among entrants when they already obtained all necessary information, but the final decision on choosing a particular institution of higher education is not adopted yet.

The "Decided" curve in the chart can be interpreted as making decision in general and not in favor of particular HEIs. In general advertisement has an impact on enrollees who are going to make a decision ("Informed" curve) or do not have enough information for making the adequate decision ("Not informed" curve).

Parameters of the model are based on a survey that was carried out in social networks. But traditional channels have its own specific of dissemination of information.

So the simulation results show just the dissemination of information in the Internet environment. Social networks and traditional channels have some common. Some time is needed for the dissemination of information. It is much less in social networks. So if you need to quickly convey information to a considerable number of enrollees are to use social networks.

5 Conclusion

Education in Ukraine is one of the competitive trends, as evidenced by leading world ratings. Therefore, promotion of educational services is a priority task in the country. But education is a specific service. In the education market, the leading place is not only for the enrollee but also for the intermediary that affects the choice of the enrollee. This is the parents who may be paying in the future for the educational services and therefore, they have an impact on the enrollee. Also significant influence is made by friends, classmates, acquaintances, and recent graduates who succeed in their careers. Thus, the greatest impact on the enrollee is made by the channels of their inner circle. So, to better promote educational services, Universities should strive to create a positive image of the institution among the inner circle of enrollees.

In the recent time, the channel that makes the most impact on customers, are social networks. They are just very popular among young people. Therefore, HEIs should use these channels to form a positive image of the institution among participants in social networking, use it to provide information of the promotional activities and events. Because a significant impact on the enrollees makes the inner circle, it is necessary to create group of the university in the social networks. Students and graduates of university have to involve in these groups. So, these groups will cover two areas of promotion: friends and acquaintances, advertising HEI.

The paper has presented an approach to define the strategy of promoting HEI among future enrollees based on Bass diffusion model of innovation. This model is widely used to predict the dissemination of new products and technologies. The analysis showed that the model of Bass is appropriate to describe the process of information dissemination on education services and can be used to simulate the behavior of students choosing HEI. Model of Bass is implemented through agent-based simulation modeling in the environment AnyLogic. The results indicate that the period of time for the most effective long-term strategy is a time when the future enrollee selects items for UPE. Starting career guidance is necessary first of all among those graduates who are still undecided in their abilities and interests due to the lack of adequate and complete information about the specialty.

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