

Intensifying Use of Big Data for Emerging Markets in Society 5.0

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Abstract: The use of Big Data is of particular interest to emerging markets, especially to business owners of enterprises selling goods and services. Big data is one of the opportunities to increase business results while meeting the needs of each client. Use of Big Data is especially actual during economic crises and in conditions of growing competition. Purpose – The main purpose of the article is to use Big Data technology for maximizing customers' satisfaction and business profits in Society 5.0 during crisis periods. Methodology – The study was based on utility theory Jules Dupuit, firm theory by Dionysius Lardner, the economics of welfare, theory Big Data. Findings – The low efficiency of discount loyalty programs is an incentive for the distribution of personalized programs has been proven. Such programs allow you to monitor the impact of the enterprise marketing policy in emerging markets on regular customers' behaviors. They also allow you to study preferences, purchasing power, and population migration. The impact of the rapid development of information technology has been investigated; in particular, the impact of Big Data technology on loyalty programs in Society 5.0 has been identified. Information component loyalty programs were classified. It will allow providing the most effective processing of consumer benefits information and increase sales, considering the features of crisis periods in economic development. Significance – The main competitive advantages of Big Data using have been identified. The importance of this technology for businesses has been proven. It should be especially used in the process of overcoming the crisis to form the optimal price for the product and maximize the results of the activity.


1 INTRODUCTION


After overcoming the consequences of the Coronavirus disease (COVID-19) pandemic and the consequences of the Russian-Ukrainian war there will be a need to take advantage of the competitive advantages of goods and services. It is necessary to be based on the basic concepts of economic theory. Can the concept of utility be used? Yes, the concept of utility was proposed by Jules Dupuit (Numa, 2016) who determined that the same product is sold at different prices to different customers. Moreover, differences in prices are irrelevant to the difference in costs. In ad-


dition, Dupuit partially discovers the conditions that are necessary for its implementation. A merchant can conduct such activities only if he is protected from competition, if he is a monopolist. This condition is necessary so that the seller can control the price. According to Dupuit's concept rising depends not only on the interests of the monopoly seller. Prices also depend on how buyers evaluate one or another thing. Based on utility theory the same product has different utility and different price that consumers are willing to pay for it. Since there are separate groups of buyers (rich, wealthy and poor), the monopolist is able to recognize these groups and consider the different willingness to pay for the product. Dupuit considered the theory of utility, primarily from the point of view of the consumer.


The issue of maximizing satisfaction of the needs and interests of individuals was studied by another

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British engineer and economist Dionysius Lardner almost simultaneously with Dupuis. Lardner (Hooks, 1971) analysed the possibilities of maximizing income from the perspective of the theory of the firm. He argued that price competition can be used as a means by which a firm is able to maximize profits. The analysis of railway tariffs allowed him to summarize the practice of their differentiation according to the distance and nature of the carried goods. He explained this differentiation by differences in elasticity: the different demands for rail transport services and the heterogeneity of the transported goods. Lardner's real contribution is to reveal the role of demand elasticity in the process of meeting the end consumers' needs.

Why will we use the theory of the economics of welfare? Pigou (Pigou, 1920) formulated the general conditions for price competition and identified its three types in the work "The economics of welfare". According to Pigou's concept general conditions fully contribute to the implementation of price competition. This happens when the demand price for any unit of goods does not depend on the selling price of any other unit of goods. This is possible only when no unit of goods can replace any other unit of the same product.

For example:

- no unit of goods sold in one market can be transferred to another market;
- not a single unit of demand presented in one market can be transferred to another market.

However, to achieve such equilibrium states information about the benefits and the purchasing capacity of buyers is necessary. This information must be accumulated considering domestic and foreign markets. In practice, it is very difficult because there are a lot of analogy products. Therefore, after overcoming the consequences of the Coronavirus disease (COVID-19) pandemic and the consequences of the Russian-Ukrainian war, the struggle for the end consumer will gain unprecedented proportions in the world.

The basic element of success will be positive emergent properties, which are focused on the emergence and development of innovations, especially when it comes to the struggle for the end consumer and emerging economy (Dzhedzhula et al., 2022; Hurochkina et al., 2021; Hordei et al., 2021). Drivers of positive emergent properties are at a high level of human capital development. Considerable attention is paid to the study of the features of the innovative development of human capital in the conditions of developing economies, and each direction and sphere of functional implementation of this resource is detailed (Czyżewski et al., 2021; Czyżewski et al.,

2022). The processes of realizing human capital in a developing economy are complicated by the consequences of the coronavirus disease (COVID-19) and the Russian-Ukrainian war. Since there are problems with the number of permanent persons and internally displaced persons both in the middle of the country and outside its borders.

2 LITERATURE REVIEW

Industry 4.0 will contribute to the emergence of a new Society 5.0. Innovative technologies of Industry 4.0 will contribute to the rapid recovery and overcoming the consequences of the Russian-Ukrainian war.

Fundamental provisions of formation Society 5.0 and implementation of innovative Industry 4.0 technologies are considered in a number of work. Kitsuregawa (Kitsuregawa, 2018) highlight the questions of how Japan is launching Society 5.0 and the vision for a future smarter society. The work of Aquilani et al. (Aquilani et al., 2020) is devoted to the advanced manufacturing solutions, augmented reality, the cloud, and big data in the emergence of a new level of social development. Rahmanto et al. (Rahmanto et al., 2021) note the potential of huge advantages of big data technology in the emergence of a new level of social development and a breakthrough revolution in people's lives thanks to the use of technologies taking into account the humanitarian aspect.

Foresti et al.; Hayashi and Nagahara (Foresti et al., 2020; Hayashi and Nagahara, 2019) highlight the role of artificial intelligence in the functioning of automated planning and data analysis with the help of smart programs, smart infrastructure, smart systems, and smart networks.

Ellitan (Ellitan, 2020) focuses on the lack of HR (human resources) skills and the existing problem of security of communication technologies, and the inability of stakeholders to change, while in society 5.0 there is a clear priority due to the reliable and stable operation of production machines, which in turn leads to the negative consequences of worker losses places through automation. for the rapid adaptation of human capital for the benefit of improving public and business services, achieving a high level of literacy in working with data and its data analysis is an important condition. Simatupang (Simatupang, 2020) noted that the slow progress of Society 5.0 can be achieved through the development of integrated information technologies in universities and education. De Felice et al. (De Felice et al., 2021) noted that in order to achieve Society 5.0 it is important to manage the transition and identify the enabling factors that

integrate Industry 4.0. According to Önday (Önday, 2019), digital transformation creates new values and becomes a pillar of the industrial policy of many countries. Therefore, in Society 5.0, the basis of quality functioning is the achievement of convergence between physical and cyberspace. But it should be noted that the key drivers of the implementation of Industry 4.0 in Society 5.0 will contribute to rapid recovery in the post-war period, new economies will emerge, the only question will be the transfer of technologies for recovery and adaptation at the fastest pace.

3 METHODOLOGY

If you determine the level of demand in various market segments and in the markets of various countries, you can set an individual price for each unit of a homogeneous product, which will be equal to the price of its demand. This price is called the reserved price of the buyer. In its pure form, such a pricing policy is difficult to implement. The company does not know the reserved price of each buyer, but also cannot know its level from the buyer, since it is in his interests to reduce its value. It is the lack of information that does not allow the full introduction of perfect price competition and the largest financial effect.

The options (based on the collected data) for setting different prices for certain consignments of goods in accordance with the same demand function are used today. In practice, it often takes the form of various kinds of discounts (depending on the size of purchases, prepaid periods, etc.). In this case, the monopolist increases the volume of sales, and the consumer can achieve certain economies of purchase volume.

Differentiation of buyers into groups with different demand functions and subsequent pricing for each such group occurs separately during market segmentation. Segmentation is usually carried out by gender, age, income level, social status. There is the practice of setting different prices for students, senior citizens, people with disabilities and people of working age. Segmentation of end consumers is being made considering price and non-price ways of increase influence on sales (figure 1), which are reflected in loyalty programs.

However, the discount loyalty programs have some disadvantages:

- the ability to saturation and, consequently, decrease the efficiency of use;
- the complexity of how to form a group of supporters as well as the completion of the closure of the current program;

- the remoteness of non-regular customers and the usual price overpricing.

Nowadays discount accumulators and bonus cards are mostly used. Among the reasons that led to a change in the accounting policies of many enterprises there is a possibility of:

- the creation of various offers for various groups of clients;
- provision of discounts in the form of a certificate is an incentive for the client to return to the purchase of well-known goods and services;
- tracking the movement of regular customers and changing their preferences.

Introduction of such loyalty programs became possible thanks to the rapid development of information technologies that are capable to solve new problems. In addition, these cards can significantly reduce the turnover of small bills. But the main feature of these changes is the personalization of discount programs.

Personalization of seller-buyer relationships, using data mining (OLAP technology), allows you to analyze the dependencies of any values contained in the database and respond to the situation quickly. Important information for the seller is not only attracting new customers, but also controlling relationships with regulars. Firstly, the sales increase may be a consequence of a successful advertising company and, secondly, sales decrease for personalized discount cards is a consequence of low level of service, which will lead to a sharp decrease in sales in the medium and long term.

Currently, in order to increase the effectiveness of consumer segmentation the enterprise is trying to group them according to the level of the product value perception. In this case consumers are allocated:

- price-sensitive and thus easily change suppliers;
- sensitive to the quality of goods and services;
- are focused on creating long-term relationships and, as a result, strive to establish long-term partnerships to improve the quality of goods and services.

Internet trade has the greatest relevance during the lockdown. It is devoid of such shortcomings that are characteristic of the real sector of the economy:

- is not strictly connected with the territory of the physical existence of the consumer;
- can be carried out without any territorial restrictions;

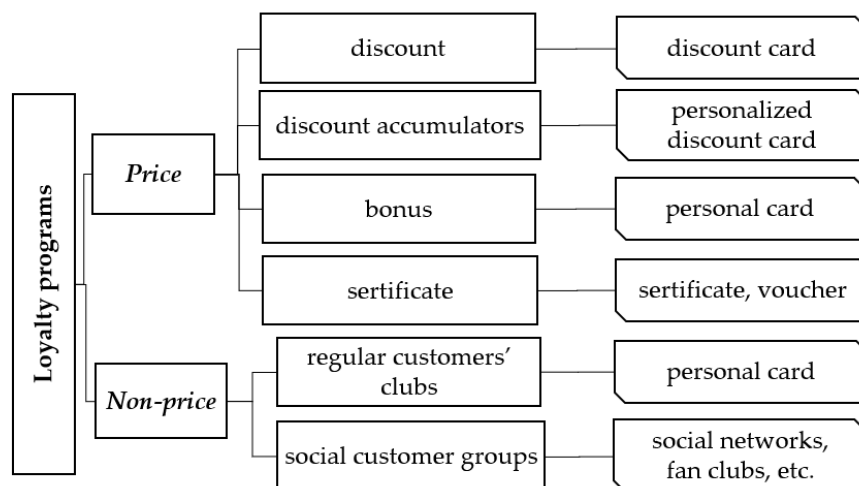


Figure 1: Classification of loyalty programs.

- the rapid development of the information society and information growth gave impetus to the development of new methods of its implementation.

In particular the Big Data theory is rapidly developing (Market Research Future, 2022). The term “Big Data” usually refers to a series of approaches, tools and methods for processing of structured and unstructured large volumes and the different nature data to obtain a consumer acceptable result. The introduction of the term “Big Data” is associated with Clifford Lynch (Lynch, 2008) who was an editor of Nature magazine and prepared a series of topical works. Quite often the “triple V” criterion is used to describe “Big Data”: volume, velocity, variety. Some leading manufacturers of business intelligence software, such as SAS (SAS Institute Inc, 2022), additionally use two more: variability and complexity. In addition to growing speeds and data varieties, data flows can also be characterized by periodic peaks. Such peak data loads can be difficult to manage. It is worth to note the complexity factor as the most important factor when you are working with Big Data. While increasing the amount of data to variable n , the number of links between them grows in proportion to $n!$ (n factorial). So the problem is not limited only to the processing of large amounts of data but also requires an additional solution to the problem of analyzing connections’ $n!$.

To identify a consumer on the Internet data for analysis is needed. The profile of the network is formed not only with the registration data on particular Internet resources but also activity in social networks, forums, blogs and the like. Thus, data reflecting the user is unstructured.

4 RESULTS

Leading corporations have developed platforms for big data business analytics (Market Research Future, 2022). In particular IBM, creating a full profile from social network data in the Big Data Analytical System, uses all the data that is more or less related to a specific consumer (table 1). At the first stage analysis of the texts takes place, at the second the linking of attributes takes place, at the third formation of statistical models and at the fourth formation of business logic take place.

Table 1: The data structure that is used to form a complete social user profile.

Full social customer profile	Personal characteristics	Identifiers
		Interests
		Social status
	Relationships	Personal
		Business
	Chronological activity	Purchase intention
		Current location
		Feedback on products and services
		Incident
	Goods and interests	Loyalty facts
		Personal relation to goods
		Shopping history
	Politics	Recommendations
		Attitude to power
		Political views
Life events	Perception of reform	
	Personal	
	Reactions to events	

Economic-mathematical modeling of the socio-

economic system based on online Big Data algorithms makes it possible to predict consumer behavior based on the identification of business logic and to form a consumer profile in the decision-making system. This method is traditional, but the selection of characteristic functional features for forecasting efficiency and optimization of Slick-Through-Rate forecasting processes is special in view of machine learning as a tool for economic and mathematical modeling of the management decision-making system.

Taking into account the presented data structure of the full profile of a social network user and the model of Big Data online algorithms, we have the possibility of flexible targeting of the target audience, adaptation of advertising content in accordance with user interests, the possibility of forecasting the effectiveness of advertising and its impact on consumer behavior. In addition, when building a model of Big Data algorithms, it is worth taking into account traffic segmentation and the Real-Time Bidding Exchange RTB auction (corresponding to the business logic of the consumer).

The use of Big Data in e-commerce provides such competitive advantages:

- 1) customer service: Big Data helps to give the consumer a sense of self-worth because his needs are maximally met by creating a certain connection between him and the brand. This cultivates consumers' loyalty and influence on their emotional level;
- 2) dynamic and point pricing: analysis of market data allows you to set an attractive price for each specific consumer;
- 3) personalization: in the process of analyzing consumers' information, personalized solutions are offered that become a competitive advantage for the client;
- 4) predictive analysis: Big Data allows you to carry out medium-term forecasting in the market and respond accordingly to possible changes in the market environment.

An example of this approach can be an application developed for the clothing brand Free People which provided sales growth of 38 percent (Dishman, 2013). The application allows users to discuss the latest collections, share their photos on Pinterest and Instagram social resources and vote for the best photos. This interaction is an example of the monetization of accumulated data by retailers using social platforms. Point discounts of Internet commerce can be divided by analogy with traditional commerce into two types depending on the technology that is used. The first type

is personalized which provides for mandatory registration on a web resource, the second is not personalized (does not require registration). The first option of a point discount is for a price offer based on customer data, a history of web surfing (viewing products on a store page) and purchase history. Retailers often use social media accounts to register. It simplifies the registration procedure and gains access to user data. This significantly increases the amount of data to be analyzed.

Based on the data (table 1) on using Big Data, a consumer profile is formed and its segment affiliation is determined. In the future the client is offered an individual price offer. The price that is offered is minimal in order for the fact of purchase. In addition, goods are offered in accordance with the target audience. In other words, an individual approach to proposals is formed based on the analytical processing of unstructured data.

For convenience we have built EPC diagram (Software AG, 2022), which is often used to describe the workflow in ArisExpress environment (figure 2). If the visitor is not a consumer of goods and services, HTTP-cookie analysis of the web page is carried out that allow carrying out authentication, storage of personal user preferences and settings, session state tracking of user access, maintain user statistics.

It is also possible when there is not enough data to determine the profile of the visitor. This may be due to both the low activity of the Internet user and his conscious reluctance to "external tracking". One such way is to use an anonymous session. In this case the basic offers are determined by the system.

For machine learning target audience targeting, we use the Datch approach, taking into account the social network user profile, to build a model of online Big Data algorithms. The Datch approach is based on two-level testing of Big Data algorithms: training dataset and test dataset. The condition of the model is the constancy of the data of the decision-making system over time. At the same time, the dynamism of the system and the resonance of news on the website can become an emergent property of the socio-economic system, which will contribute to a further change in the trend. The model of Big Data algorithms for the task of predicting CTR is based on the systematization of the modeling process by stages and on a certain set of parameters of the data structure of the complete profile of a social network user.

$$W_{sc_{p+1}} = \operatorname{argmin} \sum_{i=1}^{t-1} v(w_p, w_r, w_{ch}, w_{gi}, w_{pol}, w_t) + R(w_p, w_r, w_{ch}, w_{gi}, w_{pol}, w_t) \quad (1)$$

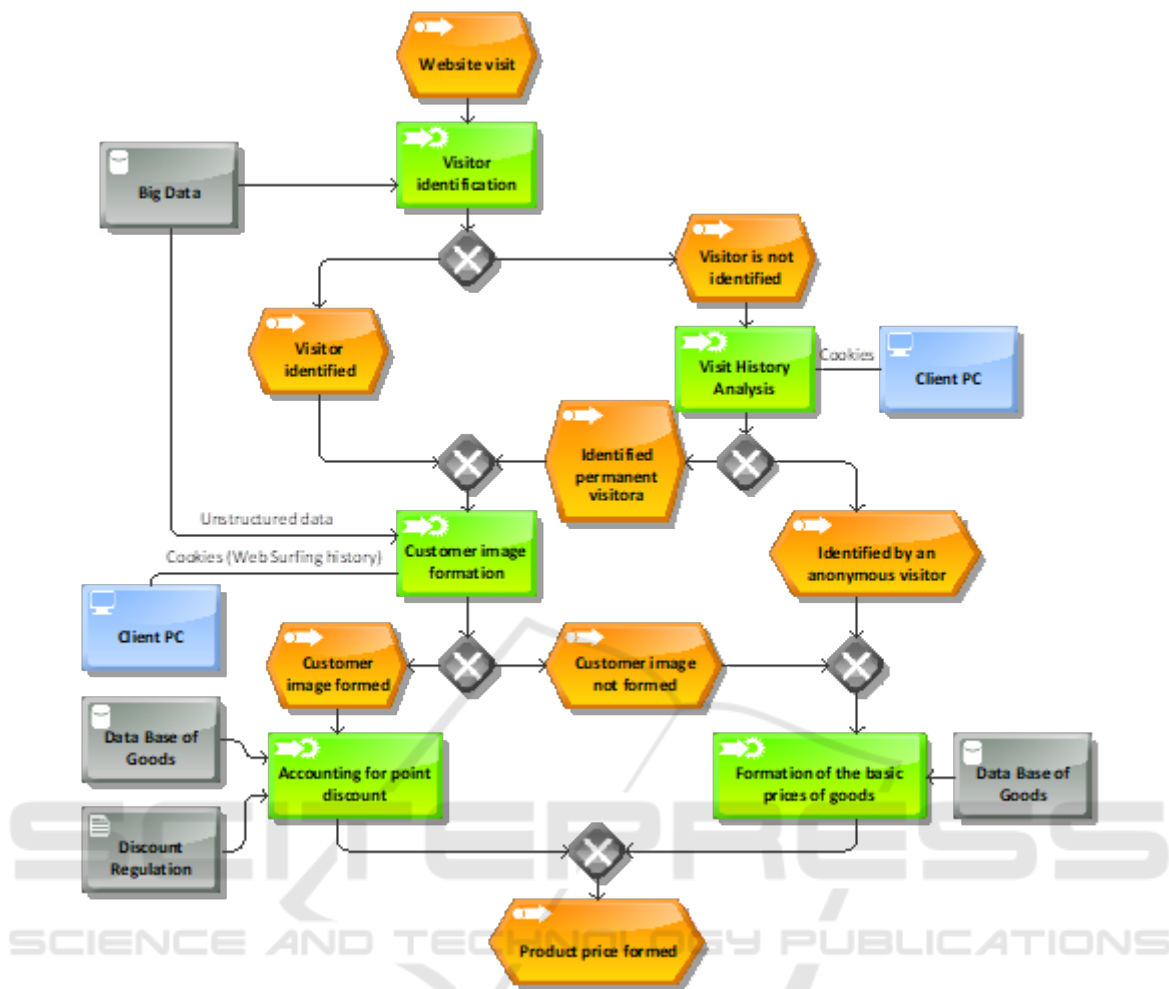


Figure 2: Structurally Logical Pricing Scheme in an EPC Chart.

where:

- $W_{sc_{p+1}}$ – function social customer profile;
- $v(w_p)$ – loss function for optimization Personal characteristics (Identifiers, Interests, Social status);
- $v(w_r)$ – loss function for optimization Relationships (Personal, Business);
- $v(w_{ch})$ – loss function for optimization Chronological activity (Purchase intention, Current location, Feedback on products and services, Incident, Loyalty Facts);
- $v(w_{gi})$ – loss function for optimization Goods and interests (Personal relation to goods, Shopping history, Recommendations);
- $v(w_{pol})$ – loss function for optimization Politics (Attitude to power, Political views, Perception of reform);
- $v(w_l)$ – loss function for optimization Life events (Personal, Reactions to events).
- $R(w_p)$ – regularization function Personal characteristics (Identifiers, Interests, Social status);

- $R(w_r)$ – regularization function Relationships (Personal, Business);
- $R(w_{ch})$ – regularization function Chronological activity (Purchase intention, Current location, Feedback on products and services, Incident, Loyalty Facts);
- $R(w_{gi})$ – regularization function Goods and interests (Personal relation to goods, Shopping history, Recommendations);
- $R(w_{pol})$ – regularization function Politics (Attitude to power, Political views, Perception of reform);
- $R(w_l)$ – regularization function Life events (Personal, Reactions to events).

The loss function for optimizing the profile characteristics of a social network user will have the following form:

$$v_t(w_p, w_r, w_{ch}, w_{gi}, w_{pol}, w_l) = \|w - x_t\|^2 \quad (2)$$

Under the conditions of a linear loss function in order to optimize the characteristics of the social net-

work user profile, the formula will have the following form:

$$v_t(w_p, w_r, w_{ch}, w_{gi}, w_{pol}, w_l) = \langle w, x_t \rangle \quad (3)$$

Under conditions of activation of emergent properties in the socio-economic system, such as dynamic system changes or trend changes under the influence of high-profile news on the site, which contribute to the manifestation of binary dependence at the bifurcation point, the function will have the following form:

$$v_t(w_p, w_r, w_{ch}, w_{gi}, w_{pol}, w_l) = \sigma((w_p, w_r, w_{ch}, w_{gi}, w_{pol}, w_l) x_t) - y_t) x_t \quad (4)$$

σ – sigmoidal function:

$$\sigma(\alpha) = \frac{1}{1 + e^{\alpha}} \quad (5)$$

With the activation of emergent properties in the socio-economic system, the regularization function will have the following form:

$$R(w_p, w_r, w_{ch}, w_{gi}, w_{pol}, w_l) = \frac{1}{2n} \|w\|^2 \quad (6)$$

Under the conditions of if $\eta > 0$, then the iteration of the machine learning algorithm will include a step-wise gradient descent algorithm and will look like:

$$w_{sc_{p+1}} = -\eta \sum_{i=1}^p z_i = W_{sc_p} - \eta z_i = W_{sc_p} - \nabla v_t(w_p, w_r, w_{ch}, w_{gi}, w_{pol}, w_l) \quad (7)$$

The resulting formula for optimizing management decisions, taking into account the parameters of the data structure of the full profile of a social network user, will look like this:

$$w_{p,i} = \begin{cases} 0 & |x_i| \leq \varepsilon_1 \\ -\left(\frac{\beta + \sqrt{n_i}}{\alpha}\right) (x_i - \text{sign}(x_i) \varepsilon_1) & |x_i| > \varepsilon_1 \end{cases} \quad (8)$$

where x and n iteration parameters, $\varepsilon_1, \varepsilon_2$ are regularization intensity parameters according to the selected type and α, β – are input parameters characterizing the learning rate.

Since, based on the above, in order to achieve the optimum at each step of the algorithm execution, the optimal decision is made and the previous ones are not foreseen, then this model belongs to the Greedy algorithm. A characteristic feature of these algorithms is relative simplicity and speed of execution.

This technique of point discount has been actively developing over the past three years. One of the first companies that offered this service was Freshplum whose founder was Sam Odai. Later Freshplum joined the TellApart company (SAS Institute

Inc, 2022), which operates in the market of services for online stores. Moreover, the algorithm for potential customers' selection of this company uses a number of "non-standard" indicators such as: place of residence (city center or outskirts), weather, etc. This allows you to increase the likelihood of making a purchase up to 36 percent (Tanner, 2014).

For the first time the analysis of differential pricing in online stores was conducted by the The Wall Street Journal. The editors conducted a study (Valentino-DeVries et al., 2012) of pricing in 200 online stores.

The economic situation in the world is extremely dependent on the geopolitical risks that can now be observed (for example the corona virus pandemic and the consequences of the Russian-Ukrainian war). Therefore, the widespread use of Big Data concept may increase the profitability of enterprises. The use of Big Data methods will become an additional source of budget revenues after taxation. This will maximally satisfy the needs of consumers whose incomes have recently been declining due to devaluation and inflationary processes. In order to increase competitiveness of European goods and services markets the use of big data is a mandatory requirement of our time.

5 CONCLUSIONS

The economic situation of all countries of the world is extremely dependent on the geopolitical risks that can now be observed (for example, a COVID-19 pandemic and the consequences of the Russian-Ukrainian war). Therefore, the widespread use of Big Data basics will increase the profitability of enterprises. The use of Big Data methods will become an additional source of budget revenues, after taxation. This will maximally satisfy the needs of consumers whose incomes have recently been declining due to devaluation and inflationary processes. In addition, in order to increase competitiveness in European markets for goods and services, the use of big data is a mandatory requirement of our time. The use of the presented economic-mathematical model will make it possible to reach the optimum at each step of the algorithm execution, the optimal decision is made according to the Greedy algorithm type, which is characterized by a fairly simple feature and speed of execution.

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