Maximizing customer satisfaction and business profits through Big Data technology in Society 5.0: a crisis-responsive approach for emerging markets*

Piotr Kulyk[1], Viktoriia Hurochkina[1,2], Bohdan Patsai[2], Olena Voronkova[2] and Oksana Hordei[2]

[1]University of Zielona Góra, 9 Licealna, Zielona Góra, 65-417, Poland
[2]State Tax University, 31 Universitetska Str., Irpin, 08200, Ukraine
[3]Taras Shevchenko National University of Kyiv, 60 Volodymyrska Str., Kyiv, 01033, Ukraine

Abstract

Big Data technology is a powerful tool for businesses in emerging markets, especially in times of crisis. It can help them understand their customers better, improve their products and services, and increase their profits. This study aims to use Big Data technology to design personalized loyalty programs that can enhance customer satisfaction and loyalty in the context of Society 5.0, a vision of a human-centered society that integrates physical and digital realms. The study builds on utility theory, firm theory, welfare economics, and Big Data theory to develop a conceptual framework for information-centric loyalty programs. These programs can use Big Data to analyze customer behavior, preferences, income, and mobility in real time and offer customized incentives and discounts. The study also explores the benefits and challenges of using Big Data technology for businesses in emerging markets, as well as its role in crisis management and recovery. The study suggests that Big Data technology is essential for businesses to gain a competitive edge and survive in the dynamic and uncertain environment of Society 5.0.

Keywords

customer satisfaction, business profits, emerging markets, crisis periods emerging markets, welfare theory, needs theory, Big Data technology, loyalty programs, predictive analysis

1. Introduction

In the aftermath of the Coronavirus disease (COVID-19) pandemic [2] and the repercussions of the Russian-Ukrainian war [3], harnessing competitive advantages in the realm of goods and services assumes paramount importance. Informed by foundational principles of economic theory, a pivotal question arises: can the doctrine of utility be effectively employed? This query finds resonance in the proposition put forth by Jules Dupuit [4], who posited that

M3E2-MLPEED 2022: The 10th International Conference on Monitoring, Modeling & Management of Emergent Economy, November 17-18, 2022, Virtual, Online

* Extended and revised version of paper [1] presented at the 10th International Conference on Monitoring, Modeling & Management of Emergent Economy.

p.kulyk@wez.uz.zgora.pl (P. Kulyk); v.hurochkina@g.elearn.uz.zgora.pl (V. Hurochkina); b.pacaj@gmail.com (B. Patsai); Voronkova303@gmail.com (O. Voronkova); ohordei@gmail.com (O. Hordei)
0000-0003-2786-4020 (P. Kulyk); 0000-0001-8869-0189 (V. Hurochkina); 0000-0001-5636-9219 (B. Patsai); 0000-0002-7956-7768 (O. Voronkova); 0000-0001-6938-0548 (O. Hordei)

the same commodity could be sold to distinct customers at disparate prices, irrespective of cost differentials. Furthermore, Dupuit's insights unveil a prerequisite condition for such a strategy – a monopolistic market position that empowers the seller with pricing authority. This monopolistic structure permits discernment between consumer groups of varying affluence, allowing for calibrated pricing based on divergent proclivities. Here, the underpinning of Dupuit's utility theory predominantly rests on the consumer's vantage.

Contemporaneously, the quest for optimizing individual needs and interests was also explored by Dionysius Lardner, a British economist and engineer. In his analysis [5], Lardner delved into maximizing income from the prism of firm theory. A significant facet of Lardner's contributions pertains to the strategic utilization of price competition to heighten profits. His scrutiny of railway tariffs furnished insights into their differential structuring based on distance and cargo characteristics, attributed to variations in elasticity and consumer demand heterogeneity. Notably, Lardner's work underscores the pivotal role of demand elasticity in satiating consumer needs.

The economics of welfare, as elucidated by Pigou [6], furnishes a pivotal framework for comprehending price competition and its multifaceted types. Pigou postulates a nexus between the feasibility of price competition and a set of general conditions, contingent on the non-interdependency of demand prices for distinct units of commodities. To this end, it necessitates a scenario where units of goods transacted in one market cannot be seamlessly transposed to another market, coupled with the restriction that units of demand in one market remain exclusively tethered to their native domain. However, achieving such equilibrium is intricate, demanding comprehensive information encompassing consumer benefits and purchasing potential across domestic and global markets. This daunting task is further compounded by the complexities introduced by analogous products. As the post-COVID-19 and post-conflict landscape unfolds, the global race for end consumers is poised to escalate.

A salient determinant of success resides in positive emergent properties, which pivot on innovation germination and progression, particularly in the realm of consumer engagement and burgeoning economies [7, 8, 9]. The catalysts of such positive emergent properties coalesce around the zenith of human capital development. Pertinently, in the context of developing economies, intricate examinations are undertaken to scrutinize innovative human capital development facets across various domains [10, 11]. The contours of human capital realization within developing economies are further compounded by the far-reaching impacts of COVID-19 and the Russian-Ukrainian war, leading to demographic shifts and internally displaced populations.

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 [12] 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. [13] 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. [14] 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. [15], Hayashi and Nagahara [16] 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 [17] 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 [18] 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. [19] 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 [20], 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

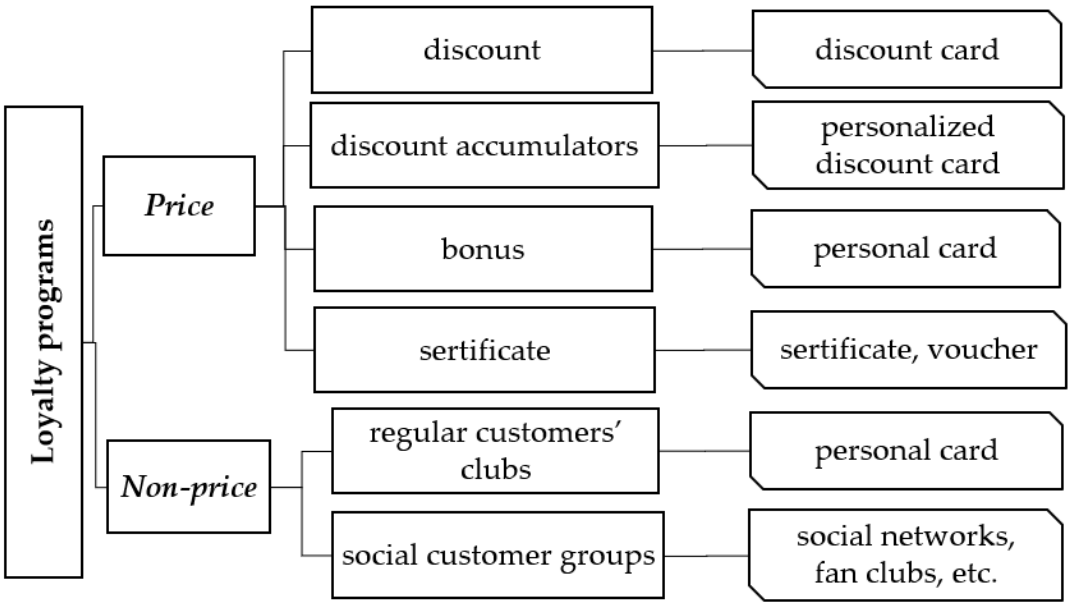

Figure 1: Classification of loyalty programs.

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;
- 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 [21, 22]. 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 [23] 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 [24], 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 [21]. 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
		Loyalty facts
	Goods and interests	Personal relation to goods
		Shopping history
		Recommendations
	Politics	Attitude to power
		Political views
		Perception of reform
	Life events	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 [25]. 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 [26], 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 [27], 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.

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

where:

$W_{sc_{p+1}}$ – function social customer profile;

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

$v(w_p)$ – 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:

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

Under the conditions of a linear loss function in order to optimize the characteristics of the social network user profile, the formula will have the following form:

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

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:

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

σ – sigmoidal function:

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

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

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

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

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

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:

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

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 [24], 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 [28].

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 [29] 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

In an era characterized by global geopolitical uncertainties, underscored by events such as the COVID-19 pandemic and the repercussions of the Russian-Ukrainian war, the economic trajectory of nations is intricately interwoven with the contours of geopolitical risks. Amidst this backdrop, the strategic assimilation of foundational principles of Big Data emerges as an indispensable tool for enhancing enterprise profitability. The application of Big Data methodologies assumes the mantle of an auxiliary revenue stream, akin to taxation, endowed with the potential to assuage the financial strains borne by consumers grappling with income diminutions catalyzed by devaluation and inflationary forces. Additionally, as European markets for commodities and services necessitate a heightened competitive edge, the incorporation of Big Data not only becomes a compelling imperative but a quintessential mandate of our epoch.

At the nexus of this pursuit lies the economic-mathematical model, a potent tool that drives optimization at each algorithmic juncture. This model, emulating the Greedy algorithm's attributes of simplicity and swift execution, engenders optimal decision-making. With Big Data as its cornerstone, this methodology fosters an environment where the quintessence of profitability and competitiveness converge to navigate the complexities of today's economic landscape.

Acknowledgments

The work was carried out within the framework of the program to support scientists from Ukraine during the implementation of the project “Mechanism to strengthen the social responsibility of refugees and people fleeing the Russian armed conflict on the territory of Ukraine” on funding from the Polish Academy of Sciences and the National Academy of Sciences of the United States and University of Zielona Góra.

References

[1] P. Kulyk, V. Hurochkina, B. Patsai, O. Voronkova, O. Hordei, Intensifying Use of Big Data for Emerging Markets in Society 5.0, in: S. Semerikov, V. Soloviev, A. Matviychuk, V. Kobets, L. Kibalnyk, H. Danylchuk, A. Kiv (Eds.), Proceedings of 10th International Conference on Monitoring, Modeling & Management of Emergent Economy - M3E2, INSTICC, SciTePress, 2023, pp. 63–70. doi:10.5220/0011931300003432.

[2] S. S. Iyer, L. Gernal, R. Subramanian, A. Mehrotra, Impact of digital disruption influencing business continuity in UAE higher education, Educational Technology Quarterly 2023 (2023) 18–57. doi:10.55056/etq.29.

[3] V. I. Kovalchuk, S. V. Maslich, L. H. Movchan, Digitalization of vocational education under crisis conditions, Educational Technology Quarterly 2023 (2023) 1–17. doi:10.55056/etq.49.

[4] G. Numa, The monetary economics of Jules Dupuit, The European Journal of the History of Economic Thought 23 (2016) 453–477. doi:10.1080/09672567.2014.951673.

[5] D. L. Hooks, Monopoly Price Discrimination in 1850: Dionysius Lardner, History of Political Economy 3 (1971) 208–223. URL: https://EconPapers.repec.org/RePEc:hop:hopeec:v:3:y:1971:i:1:p:208-223.

[6] A. C. Pigou, The Economics of Welfare, Macmillan & Co., London, 1920. URL: https://oll.libertyfund.org/title/pigou-the-economics-of-welfare.

[7] V. Dzhedzhula, V. Hurochkina, I. Yepifanova, A. Telnov, Fuzzy Technologies for Modeling Social Capital in the Emergent Economy, WSEAS Transactions on Business and Economics 19 (2022) 915–923. doi:10.37394/23207.2022.19.80.

[8] V. Hurochkina, S. Reshmidilova, L. Bohatchyk, A. Telnov, L. Skorobogata, N. Riabinina, Modeling Effectiveness of Financial Support for the Social Capital Development in Economic Emergence, WSEAS Transactions on Environment and Development 17 (2021) 262–270. doi:10.37394/232015.2021.17.27.

[9] O. Hordei, B. Patsai, V. Hurochkina, O. Ovdiienko, R. Mishchenko, Optimization of the Investment Portfolio in the Environment of Table Processor MS Excel, Studies of Applied Economics 39 (2021). doi:10.25115/eea.v39i5.4983.

[10] B. Czyżewski, A. Sapa, P. Kułyk, Human Capital and Eco-Contractual Governance in Small Farms in Poland: Simultaneous Confirmatory Factor Analysis with Ordinal Variables, Agriculture 11 (2021) 46. doi:10.3390/agriculture11010046.

[11] B. Czyżewski, A. Poczta-Wajda, P. Kułyk, J. Drozdz, Small farm as sustainable nexus of contracts: understanding the role of human capital and policy based on evidence

from Poland, Environment, Development and Sustainability (2022). doi:10.1007/s10668-022-02485-2.
[12] M. Kitsuregawa, Transformational Role of Big Data in Society 5.0, in: 2018 IEEE International Conference on Big Data (Big Data), 2018, pp. 3–3. doi:10.1109/BigData.2018.8621989.
[13] B. Aquilani, M. Piccarozzi, T. Abbate, A. Codini, The Role of Open Innovation and Value Co-creation in the Challenging Transition from Industry 4.0 to Society 5.0: Toward a Theoretical Framework, Sustainability 12 (2020) 8943. doi:10.3390/su12218943.
[14] F. Rahmanto, U. Pribadi, A. Priyanto, Big Data: What are the Implications for Public Sector Policy in Society 5.0 Era?, IOP Conference Series: Earth and Environmental Science 717 (2021) 012009. doi:10.1088/1755-1315/717/1/012009.
[15] R. Foresti, S. Rossi, M. Magnani, C. Guarino Lo Bianco, N. Delmonte, Smart Society and Artificial Intelligence: Big Data Scheduling and the Global Standard Method Applied to Smart Maintenance, Engineering 6 (2020) 835–846. doi:10.1016/j.eng.2019.11.014.
[16] N. Hayashi, M. Nagahara, Distributed Sparse Modeling for Society 5.0: Big Data Analysis over Multiagent Networks, IEICE ESS Fundamentals Review 13 (2019) 95–107. doi:10.1587/essfr.13.2_95.
[17] L. Ellitan, Competing in the Era of Industrial Revolution 4.0 and Society 5.0, Jurnal Maksipreneur: Manajemen, Koperasi, dan Entrepreneurship 10 (2020) 1–12. doi:10.30588/jmp.v10i1.657.
[18] A. Simatupang, Digitalisasi dan Internasionalisasi Pendidikan Tinggi Dalam Pembentukan Society 5.0 dan Industri 5.0, in: L. Sintha, T. Guswantoro, F. Tobing, A. A. Purnamasari, S. Putra (Eds.), Digitalisasi dan Internasionalisasi Menuju APT Unggul dan UKI Hebat, UKI Press, 2020, p. 217–218. URL: http://surl.li/dzmxm.
[19] F. De Felice, M. Travaglioni, A. Petrillo, Innovation Trajectories for a Society 5.0, Data 6 (2021) 115. doi:10.3390/data6110115.
[20] Ö. Önday, Japan's Society 5.0: Going Beyond Industry 4.0, Business and Economics Journal 10 (2019) 1000389. URL: https://www.academia.edu/39149435/Japan_s_Society_5_0_Going_Beyond_Industry_4_0.
[21] Market Research Future, Healthcare Big Data Analytics Market Size, Growth | Industry Trends, 2030, 2022. URL: http://surl.li/dzmwt.
[22] Z. Seidametova, Z. Abduramanov, G. Seydametov, Hackathons in computer science education: monitoring and evaluation of programming projects, Educational Technology Quarterly 2022 (2022) 20–34. URL: https://acnsci.org/journal/index.php/etq/article/view/5. doi:10.55056/etq.5.
[23] C. Lynch, How do your data grow?, Nature 455 (2008) 28–29. doi:10.1038/455028a.
[24] SAS Institute Inc, Big Data Analytics: What it is and why it matters, 2022. URL: https://www.sas.com/en_us/insights/analytics/big-data-analytics.html.
[25] L. Dishman, How Free People is Using Big Data and Social Commerce for Bigger Sales, 2013. URL: http://surl.li/dzmwk.
[26] Software AG, Event-driven process chain (EPC), 2022. URL: https://www.ariscommunity.com/event-driven-process-chain.
[27] V. Derbentsev, A. Matviychuk, V. N. Soloviev, Forecasting of cryptocurrency prices using machine learning, in: L. Pichl, C. Eom, E. Scalas, T. Kaizoji (Eds.), Advanced Studies

of Financial Technologies and Cryptocurrency Markets, Springer, Singapore, 2020, pp. 211–231. doi:10.1007/978-981-15-4498-9_12.

[28] A. Tanner, Different Customers, Different Prices, Thanks To Big Data, 2014. URL: https://cutt.ly/q018Ugn.

[29] J. Valentino-DeVries, J. Singer-Vine, A. Soltani, Websites Vary Prices, Deals Based on Users' Information, The Wall Street Journal (2012). URL: https://www.wsj.com/articles/SB10001424127887323777204578189391813881534.