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Article

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CONSUMER ATTITUDE TOWARDS THE USE OF BLOCKCHAIN TECHNOLOGY. STUDY ON THE IMPLEMENTATION OF THE “GREEN DEAL” STRATEGY FOR ORGANIC FOODS

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Abstract

The European Union aims for Member States to achieve climate neutrality by 2050. To this end, the European Commission has launched a set of policy initiatives in The European Green Deal. One of the components is the Farm to Fork strategy, through which the European Union aims to increase, among other things, to 25% of the agricultural areas with organic production, as well as new labeling rules to promote the sustainable consumption of food and organic food. A modern technology that can be used for food traceability is Blockchain technology. The main objective of this paper is to study consumers' perceptions of the possibility of using blockchain technology in the distribution of “organic” food products. The research was quantitative and followed the specific aspects of the blockchain concept and its use in the distribution and tracking of food and ecological goods, “organic”. The aim of the research was to develop a predictive model, using the basic regression equation, to obtain a positive perception of the use of blockchain technology for food and environmental goods.

Keywords: blockchain, consumer trust, agri-food industry, organic food

JEL Classification: L66, L15, C20

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Introduction

We live in an era of profound transformation, and some of the most important concerns of the moment, in addition to the challenge of providing sustainable food sources for the world's population, are the increase in consumer confidence that the products they use are quality and the existence the possibility of following the route they have taken before reaching the final consumer. People are paying more and more attention when it comes to their own health, as well as that of the planet. The European Union has decided to implement a system of measures to improve the effectiveness of countries to make them more resource efficient. This system is also a way to increase competitiveness. That is why a strategy called The European Green Deal was launched. It aims to eliminate greenhouse gas emissions over the next 30 years, to sustain economic growth but not be resource-dependent, and also to ensure that every individual and everything is taken into account. (European Commission, 2021). An important part of the European Green Deal is the Farm to Fork strategy. The food system is very important when it comes to environmental change. Its sustainability is essential, and its negative impact on the planet, health, and the economy must be reduced. Sustainability needs to be planned at all levels: production, processing, and distribution, as well as food consumption (European Commission, 2021). The aim of the European Union is to secure the food system despite climate change and losses in species diversity, to create a sustainable structure, to minimize the footprint of the system and to make it more resilient (European Commission, 2021).

Consumer confidence is essential for the proper functioning of global food systems. It is important because it plays a critical role in the community-based operation of food systems, a concept often known as a social operating license. According to studies, consumers in Romania lack information on hazards and do not have best practices when it comes to selecting the right, healthy product, according to studies. Although scientific books have a high level of trust, the information offered is not taken into account throughout the purchasing process. In fact, customers are aware of certified labeled foods without having knowledge of their definition. They are also often afraid of ingredients that a product possesses that are not harmful (Borda et al., 2021).

In the context of Industry 4.0, developing countries are in a state of gradual technological transition. In the agricultural supply chain, this transition can be seen in the form of digitization and resource management. In this sense, the concept of precision agriculture has emerged, which is a type of intelligent agriculture that involves the introduction of high-performance technologies and equipment to streamline the agricultural process and ensure production control. At the same time, one of the main ways organizations can upgrade their systems to meet consumer requirements for new standards of transparency and security is the implementation of blockchain technology (Yadav et al., 2020). Blockchain is a technology that makes data security possible when it comes to recording and transmitting information across a chain. Blockchain technology is revolutionizing the agri-food industry by being able to monitor all the information related to a product's life cycle, from production to processing, and finally to distribution. The main advantage of this technology is that it is resilient to data corruption by using decentralized and distributed databases that require the consent of all participants in data validation. (Ministère de l'Agriculture et de l'Alimentation, 2019). Blockchain is a method presented to the public after the advent of cryptocurrencies, but its usefulness is now being tested in other areas.

This research aims to analyze the importance of tracking the path of food and it measures the level of consumer trust in the use of such technology. In this regard, quantitative

research that uses a survey has been created with the intent of discovering the specific details of the blockchain concept and the utilization of this technology in the distribution and tracking of bio foods.

As a result, the work continues with a section devoted to reviewing the specialized literature, followed by one that describes in detail the research methodology, and finally one that summarizes the main conclusions, as well as the limitations of current research and potential future research directions.

1. Review of scientific literature

The new wave of technologies in the field of automation and digitization brings major benefits to all industries and fields of activity. One of the new technologies that is successfully applied in the field of cryptocurrencies, but which is also starting to find outlets in the logistics, medical history, pharmaceutical, and real estate sectors is blockchain technology. The process in a blockchain-based network is different from other databases because data validation is done by consensus of participants. Then, once the data is confirmed and the block is generated, it remains unchanged. Therefore, it is very difficult for hackers to attack stored data. In the food industry, for example, blockchain technology can be used for food traceability, facilitating the connection between members of the distribution chain and at the same time giving them the confidence that information cannot be subject to unauthorized changes (Niknejad et al., 2021). These features provide a greater level of customer confidence. (Ferreira da Silva and Moro, 2021). The concept of blockchain was first introduced by Stuart Haber and W Scott Stornetta in 1991, and developers working under the pseudonym Satoshi Nakamoto implemented the first blockchain in which transactions are made using electronic currency known as Bitcoin and transaction records are kept by a public registry (Upadhyay et al., 2021). Although the blockchain was created to support Bitcoin, it now has a wide range of applications (Ferreira da Silva and Moro, 2021). Researchers investigated blockchain technology in 2014 and discovered that it can protect a variety of applications, including financial applications, party contracts, inter-organizational transactions, IoT (Internet of Things) systems, banking systems, and functional registers, among others (Centobelli et al., 2021). As a result, blockchain solutions are being used in a variety of industries, including healthcare, supply chain management, marketing, insurance, patents, and copyright. Today's technology helps us limit fraud, and blockchain is a good alternative for business because it is safer and easier to trace data (Euromonitor International, 2019).

Consumer trust is the foundation of their loyalty, dedication, product acceptance, and long-term relationships with businesses (Upadhyay et al., 2021). Transparency also plays a role in trust development, since stated actions to protect consumer data, production transparency, working conditions, and social responsibility all help to build confidence (Kumar and Sharma, 2021). Several organizational sins, such as the Volkswagen emissions scandal, the Cambridge Analytica scandal, and the global financial crisis of 2007, have resulted in a loss of trust among the general public (Upadhyay et al., 2021). Because the central entity can be the main starting point for a failure, a centralized data system can erode user confidence. Consumer confidence can be bolstered by the dispersed network of blockchain nodes and the features of manipulation resistance (Centobelli et al., 2021). The almost impossible possibility of changing previously published blocks without being

noticed, the digital cryptographic signature of each piece of information published in the register of evidence, and the transparency provided by tracking the information published in a decentralized chain of blocks put together are some of the features that make blockchain technology so appealing to consumers (Kumar and Sharma, 2021). To some extent, blockchain technology can replace trust in platform providers, but it also raises concerns about algorithmic trust. Third-party trust is transferred to a blockchain system (Centobelli et al., 2021). Because it provides transparency and monitoring capabilities, blockchain has the potential to play a significant role in the development of sustainability (Esmaeilian et al., 2020). According to research, the use of blockchain to trace the course of organic tea is helpful and part of the idea of sustainability, especially due to the technology requiring no specialized organization to record every step (Paul et al., 2021). Blockchain technology is well suited for tracking food in the production chain and can play an important role in the new European Union strategy, called the Farm to Fork strategy.

As intended, the Farm to Fork strategy aims to achieve a circular economy, i.e., minimizing waste, by introducing into production and marketing biodegradable and/or recyclable products, through measures aimed at transport, storage, packaging, and waste. food. It also aims to stimulate sustainable food consumption and promote healthy eating. By implementing new labeling rules, European consumers will have access to details such as the place of origin of food, their nutritional value, and the carbon footprint generated.

Industry 4.0, according to Ali et al. (2021), includes the use of blockchain in the manufacturing process to improve customer service. Industry 4.0 refers to the dynamic worldwide interconnected network from a technical standpoint. It is used to connect people, goods, and processes over a worldwide network in order to improve global competitiveness and provide network connection. At least five main attributes of the can be highlighted and detailed using blockchain technology: nature, quality, quantity, location, and ownership (Ferreira da Silva and Moro, 2021). In this approach, blockchain allows a business, on the one hand, to identify who is responsible for the quality of the product or service it provides. Customers, on the other hand, can view the product's history from the raw material to the finished product (Centobelli et al., 2021). Apart from the level of customer satisfaction, which indicates a positive variance, the flexibility and responsiveness of supply chain activities appear to be unaffected (Stranieri et al., 2021). The characteristics underlying the technology, particularly peer sharing, distributed storage capacity, security handling resistance, and the ability for secure automation, all contribute to the attraction of blockchain systems for various sectors (Upadhyay et al., 2021). Farmers, for example, may benefit greatly from the blockchain system since it would make it easier for them to connect with retailers and consumers. Government intervention is also required in this area in order to construct a well-developed and decentralized framework (Sivalakshmi et al., 2021).

The necessity of such technologies could help to avoid food contamination issues. Yadav et al. (2020) conducted a study to determine what the barriers to blockchain integration in India's supply chain would be. The major issues arise from a lack of trust and a lack of regulations. According to a study conducted in Romania, those who work in services, such as software, have a greater knowledge of what IoT (Internet of Things) means than those who work in production (Szentesi et al., 2021).

In practice, blockchain technology can be implemented, but there are cases where stakeholders have inefficient processes and outdated technology. From this perspective, considerable technological improvements and process standards will be required before

blockchain technology can be implemented. One key disadvantage is that integrating blockchain-based technology into the supply chain requires the involvement of many, if not all, supply chain actors, as well as intensive coordination and collaboration between them. Another issue is that, despite the fact that data on the blockchain cannot be modified after it is entered, the data entered may still be of inferior quality (Köhler and Pizzol, 2020). Furthermore, when it comes to managing competition, blockchain technology could be problematic. It is the manner in which this technology is used, not the fact that it exists, that poses a threat to unfair competition (Maggiolino and Zoboli, 2021).

Due to the lack of industry-wide process standardization and the required adoption of technology, it is likely that blockchain technology would only assist supply chains if internal traceability is well exercised by each participant (Bumblauskas et al., 2020). The current difficulty with blockchain technology is to extend these use cases to other products. Consumers may be more concerned about pesticide residues in fresh fruits and vegetables; conversely, they may be more concerned about authenticity and provenance in frozen seafood, or whether it has been thawed and refrozen during transportation. Both the data uploader and the blockchain system will face challenges in monitoring each of these individual factors (Xu et al., 2020). Furthermore, existing or future technical trends such as the Internet of Things (IoT), RFID (radio frequency identification), sensor devices, cloud computing, and machine learning need to be supplemented by blockchain technology for effective application (Saurabh and Dey, 2021).

“The ability to locate an animal, a commodity, a food, or an ingredient and track its history in the supply chain forward (from source to consumer) or back (from consumer to source) is defined as agri-food traceability” (Garaus and Treiblmaier, 2021). Current traceability techniques do not provide consumers with full visibility in the supply chain due to the complexity and fragmentation of agri-food supply chains (Cao et al., 2021). Consumer confidence can be increased by using traceability data from an integrated traceability system that connects all stakeholders in the chain, according to Yang et al. (2021). However, further research is needed to investigate blockchain applications with real-world use cases, particularly by incorporating customer feedback and opinions (Feng et al., 2020). Traceability (tracking) is critical in the food supply chain to ensure food safety and quality (Cao et al., 2021). Traceability is a component of logistics management that refers to the ability to assess data using registered identifications. Increasing traceability requires the collection of more data and the attribution of specific tasks to various supply chain partners. It is critical that traceability allows for the availability of information connected with a specific product (Yang et al., 2021). Some governments invest extensively in blockchain technology, recognizing its enormous potential, particularly in the food sector, where consumers are more concerned about their own health and, as a result, product quality (Mirabelli and Solina, 2020). However, in order to overcome the blockchain's restrictions, persistent effort is required. The use of blockchain technology in agricultural supply chains will make it easier for decision makers to make decisions about agricultural product laws and certifications (Kamble et al., 2020). For things to operate properly, packaging, labeling, and other critical issues must be addressed properly. Furthermore, according to a study published this year, the combination of “Ethereum blockchain” and “Interplanetary file system” could be used to ensure the supply system's proper operation (Rana et al., 2021).

2. Methodology

The overall objective of the study was to look at the specifics of the blockchain idea and its use in the distribution and tracking of food and environmentally friendly, "organic" products. The following are the key goals:

- identifying the potential for blockchain technology to be used in the distribution of "organic" food;
- identifying the utility of employing this technology in the distribution and tracking of "organic" food on the market;
- determination of the positive effects of using this technology in the "organic" food distribution chain.

For the study, a survey was chosen. The sampling procedure was simple random selection. The study was based on a quantitative method and was designed according to Cătoi et al. (2009).

The questionnaire was divided into two sections: one for collecting data on the respondents' knowledge, opinion, and perceptions on the use of blockchain technology in the distribution and tracking of "organic" foodstuffs, and the other for collecting socio-demographic data. The data gathering step took place on the Google.forms platform between October 15 and November 15, 2021. Following the cleaning stages, 300 valid questionnaires were obtained from the 417 completed.

9% (n = 27) of the 300 respondents in the study said they had never heard of at least one of the two ideas used in the study. Due to these factors, they were eventually removed from the study, which had a total of 273 participants. Men account for 42.9% of the population, while women account for 57.1%.

In terms of educational attainment, 86.1% have completed high school/college, 11.7% have previously graduated from college, and 2.2% have completed postgraduate study.

The majority of them are under the age of 21 (60.8%), and the majority of them have monthly wages of less than 2,000 lei.

3. Results and discussion

When it comes to the use of blockchain technology in the distribution of "organic" food, 40.3% of the respondents believe that it is largely feasible. On the other hand, the use of this technology in the distribution and tracking of "organic" food products is viewed as largely useful by 47.6% of the respondents. Lastly, more than two thirds (69.2%) view the impact of adopting this technology for the "organic" food distribution chain as good in the medium and long term.

We are interested on how the analyzed variables interact or impact one another, so we can figure out which aspects act independently and which ones combine to provide a positive perception of blockchain technology.

When we look at the relationship between the effects of blockchain technology and the possibility of using it, we can see that the differences are statistically significant ($\chi^2(4) = 69.601$, $p = 0.000$) and that there is a moderately positive correlation (Cramer's coefficient $V = 0.357$), statistically significant ($p = 0.000 < 0.05$) between the two variables.

At the same time, there are statistically significant differences ($\chi^2(4) = 72.656$, $p=0.000$) and a somewhat positive association (Cramer's coefficient $V = 0.365$; $p = 0.000$) between the impacts of using blockchain technology and its usefulness.

Furthermore, the benefits of blockchain technology are positively related to increased confidence in purchased or consumed "organic" goods (Cramer's coefficient $V = 0.245$; $p<0,001$) and, more importantly, in the products' origin (Cramer's coefficient $V = 0.366$; $p = 0.000$), (Table no. 1).

Table no. 1. The effects of using blockchain technology in the medium and long term food supply chain

		The effects of using this technology in the medium and long term for the "organic" food distribution chain are:			Total	Significance test
		negative	Neither nor	positive		
Do you think it is possible to use blockchain technology in the distribution of "organic" food?	To a small degree	81.8%	21.9%	12.7%	17.9%	$\chi^2(4) = 69.601$, $p=0.000$ Positive association of moderate intensity Cramer's coefficient $V = 0.357$; $p=0.000$
	Neither nor	18.2%	65.8%	33.9%	41.8%	
	To a large degree		12.3%	53.4%	40.3%	
Total		100.0%	100.0%	100.0%	100.0%	
Do you consider it useful to use this technology in the distribution and marketing of "organic" food?	To a small degree	63.6%	16.4%	9.5%	13.6%	$\chi^2(4) = 72.656$, $p=0.000$ Positive association of moderate intensity Cramer's coefficient $V = 0.365$; $p=0.000$
	Neither nor	36.4%	67.1%	28.0%	38.8%	
	To a large degree		16.4%	62.4%	47.6%	
Total		100.0%	100.0%	100.0%	100.0%	
Would using this technology increase your confidence in buying or consuming "organic" food?	To a small degree	54.5%	11.1%	11.1%	12.9%	$\chi^2(4) = 32.687$, $p=0.000$ Positive association of moderate intensity Cramer's coefficient $V = 0.245$; $p<0.001$
	Neither nor	45.5%	38.9%	21.2%	26.8%	
	To a large degree		50.0%	67.7%	60.3%	
Total		100.0%	100.0%	100.0%	100.0%	
Can the safety of product origin be an effect of using this technology?	no	72.7%	42.5%	16.9%	26.0%	$\chi^2(3) = 30.843$, $p=0.000$ Positive association of moderate intensity Cramer's coefficient $V = 0.336$; $p=0.000$
	yes	27.3%	57.5%	83.1%	74.0%	
Total		100.0%	100.0%	100.0%	100.0%	

		The effects of using this technology in the medium and long term for the "organic" food distribution chain are:			Total	Significance test
		negative	Neither nor	positive		
Finding the origin of the product	no	81.8%	56.2%	34.9%	42.5%	$\chi^2(2) = 16.980$, $p=0.000$ Positive association of moderate intensity
	yes	18.2%	43.8%	65.1%	57.5%	
Total		100.0%	100.0%	100.0%	100.0%	Cramer's coefficient V = 0.249; $p=0.000$

The aim was to develop a predictive model for gaining a positive perception of the use of blockchain technology. For this, we chose the variables in the model while considering the statistical significance of their interactions, and we double-checked the significance of the primary statistical elements that describe the model's likelihood and predictive power and then for testing the proposed explanatory model using: the G2 test of odds ratios (the main indicator that shows us to what extent the proposed explanatory model is or is not statistically significant), The Hosmer and Lemeshow test (which tests the null hypothesis that the observed data are generated by the proposed explanatory model) and the determination of the explanatory efficiency of the model using statistical indicators to measure the independent variable's influence on the dependent variable: C2 and Snell's R2, Nagelkerke's R2, Pseudo-R2, McFadden's R2, McFadden's R2 (adjusted), as previously stated.

We created an ordinal logistic regression model using $Y = \text{The effects of employing blockchain technology in the medium and long term food chain}$ as a dependent variable and the other factors as covariates to meet the research objectives. We need to determine if the first model can predict anything. First, we must evaluate whether the model enhances our ability to forecast the outcome before we begin analyzing the effects of each explanatory variable included in the model. We do this by comparing a model with no explanatory variables (the reference model or "only constant") to a model with all of the explanatory factors stated above (the model with all explanatory variables) (the "final" model - with several explanatory variables). We compare the completed model to the baseline to evaluate if it significantly improves data matching. We measured the odds ratio, which is essential in logistic regression to check the model's overall fit. As a result, we can say that the model is useful in forecasting the likelihood that the categories collected in the dependent variable will occur. Indeed, the empirical model value reached by the probability ratio has a value of 133,453 with 15 degrees of freedom, and its significance is complete, rejecting the null hypothesis that all of the model's coefficients, except the constant, are zero, with an error probability of less than 5%. As a result of the statistical significance of the data, model 1 with the variables input greatly improves the fit when compared to the model with just constants.

Pearson chi-square and chi-square statistics were calculated based on the deviation. These statistics are used to determine whether the observed data are consistent with the adapted model. In terms of the measure of fit, we can see that the model's significance is greater

than 0.05, indicating that it is adequate for data matching. We begin with the null hypothesis that the match is satisfactory. If we do not reject this hypothesis (i.e., if the p-value is greater than 0.05), the data and the model predictions are similar, indicating that the model is good.

Another global matching measure estimates the fraction of variance explained by the resulting logistic regression model. The R^2 coefficient of Nagelkerke indicates that the probability of occurrence of the dependent variable categories (50.8 %) is predictive, implying that the remaining 49.2 % is explained by factors not included in the model.

Table no. 2 illustrates the model parameter estimation, as well as the significance test of each predictor and the confidence range for each parameter. There are variables in the created model that have little significance, their significance tests have p values greater than 0.05, and so can be deleted.

Table no. 2. Logit coefficients and odds ratios for the predictors of the logistic regression model

Parameter Estimates							95% Confidence Interval	
		Estimate	Std. Error	Wald	df	Sig.	Lower Bound	Upper Bound
Threshold	[Y=1]	5.565	4.857	1.312	1	.252	-3.956	15.085
	[Y=2]	9.076	4.883	3.456	1	.063	-.493	18.646
Location	X ₁ = Increasing trust in sellers	-.604	.367	2.708	1	.100	-1.323	.115
	X ₂ = Safety regarding the origin of the product	1.516	.404	14.102	1	.000	.725	2.308
	X ₃ = Finding the origin of the product	.825	.374	4.864	1	.027	.092	1.559
	X ₆ = Monthly income	.699	.252	7.702	1	.006	.205	1.193
	X ₁₀ = Familiarization with blockchain technology	-1.108	.293	14.268	1	.000	-1.683	-.533
	X ₁₁ = The usefulness of blockchain technology	1.000	.316	9.999	1	.002	.380	1.619
	X ₁₂ = Increasing confidence in “organic” foods bought or consumed	.472	.299	2.489	1	.115	-.114	1.059
	X ₅ = Using an associated QR code	-.388	.365	1.132	1	.287	-1.103	.327
	X ₁₅ = Possibility to use blockchain technology in the distribution of “organic” food products	1.040	.315	10.905	1	.001	.423	1.657
	X ₄ = Possibility to “track” the product	-.950	.360	6.978	1	.008	-1.654	-.245
	X ₁₃ = Familiarization with QR code types	.656	.249	6.942	1	.008	.168	1.144
	X ₁₄ = Increasing the security of the products purchased / consumed by associating a QR code	-.474	.327	2.106	1	.147	-1.114	.166

Parameter Estimates								
							95% Confidence Interval	
		Estimate	Std. Error	Wald	df	Sig.	Lower Bound	Upper Bound
	X ₇ = Age	.096	.213	.205	1	.651	-.321	.514
	X ₈ = Gender	.338	.364	.864	1	.353	-.375	1.050
	X ₉ = Level of education	1.244	.548	5.148	1	.023	.169	2.319

By removing the variables X₁, X₁₂, X₅, X₁₄, X₇, X₈, we may enhance this ordinal logistic regression model and obtain the following findings, which demonstrate the validity of the new model (Table no. 3, Table no. 4 and Table no. 5):

Table no. 3. Pattern matching information

Model	-2 Log Likelihood	Chi-Square	df	Sig.
Intercept Only	376.830			
Final	258.375	118.455	8	.000

Table no. 4. Match measurement

	Chi-Square	Df	Sig.
Pearson	259.501	248	.295
Deviance	245.788	248	.528

Table no. 5. Pseudo R² coefficients

Cox and Snell	.353
Nagelkerke	.458
McFadden	.295

The R² proportion quantifies the degree of consistency between observations and forecasts, i.e. the accuracy of predictions. The following approach is used in its formation: The likelihood of each individual being in one of the three scenarios is estimated (negative effects, no, no, positive effects). The subjects are divided into two groups based on the determined likelihood. The correctness of the classification is compared to the observed results based on this categorization of individuals based on the estimates provided by the logistic regression equation. The ratio between the right predictions and the total predictions yields an overall result. There has been a percentage of 45.8% of the right answers according to the observed data.

The ratio between the number of valid predictions and the number of observations of an event called the degree of sensitivity. In our case for instance, it refers to the ratio of correct predictions about „positive” answers, from the total number of positive answers observed.

$$\text{Degree of sensibility} = \frac{165}{188} = 87.8\% \quad (1)$$

We can discuss 23 examples of incorrect predictions (23 false negatives - predicted with a negative perception of the effects).

The specificity of the number of successful predictions and the number of events seen can also be calculated. The model correctly estimated 165 of the 201 respondents who were predicted to have a positive perception of the effects in the “positive effects” category.

$$\text{Degree of specificity} = \frac{165}{201} = 82.1\% \quad (2)$$

There are 36 cases that have been misdiagnosed (false positives). Simultaneously, the following table (Table no. 6) shows the parameter estimates for the remaining variables in the new logistic regression model.

Table no. 6. Logit coefficients and odds ratio for predictors of the regression model

Parameter Estimates							95% Confidence Interval	
		Estimate	Std. Error	Wald	df	Sig.	Lower Bound	Upper Bound
Threshold	[Y=1]	2.183	.900	5.886	1	.015	.419	3.946
	[Y=2]	5.426	.951	32.549	1	.000	3.562	7.290
Location	X ₁₀ = Familiarization with blockchain technology	-1.222	.275	19.718	1	.000	-1.761	-.682
	X ₁₁ = The usefulness of blockchain technology	1.157	.290	15.941	1	.000	.589	1.725
	X ₁₅ = Possibility to use blockchain technology in the distribution of “organic” food products	1.023	.292	12.269	1	.000	.451	1.596
	X ₆ = Monthly income	.486	.230	4.459	1	.035	.035	.938
	X ₁₂ = Increasing confidence in “organic” foods bought or consumed	-.694	.337	4.228	1	.040	-1.355	-.032
	X ₂ = Safety regarding the source of products	1.472	.345	18.234	1	.000	.796	2.147
	X ₃ = Find out the origin of the product	.776	.330	5.519	1	.019	.129	1.423
	X ₁₃ = Familiarization with QR code types	.641	.218	8.629	1	.003	.213	1.069

As pointed out, the selection of variables is made taking into account the significance of the coefficients. In this case, of model 2, the p value of the coefficients is less than 0.05, which ensures that, statistically, they are significantly different from zero.

According to the resulting predictive model, in the perception of the effects of using blockchain technology in the medium and long term "organic" food distribution chain, it is delimited as explanatory factors: familiarization with blockchain technology, usefulness of blockchain technology, possibility of using blockchain technology in "bio" food supply distribution, increasing confidence in "bio" food purchased or consumed, safety of products, finding out the origin of the product, familiarization with QR code types and monthly income. Therefore, the parallel line hypothesis test required to validate the ordinal regression approach was calculated. The hypotheses are: H0: The parameters β_i are the same for all response levels, H1: The parameters β_i are not the same for all response levels.

Because the value of p is greater than 0.05 ($p = 0.061$), the null hypothesis is not rejected, indicating that the ordinal logistic model is valid, as the equality of slopes (β_i) is not rejected.

The analogous terms of interception are estimates labeled 'Threshold'. We are interested in estimates labeled "Location". The coefficients for the prediction variables are listed here. The number of coefficients presented in intercepted models is one less than the number of categories of the dependent variable, as is always the case with categorical predictors. The coefficients in this situation are for the values 1 and 2. The reference category, with a coefficient of 0, is the third.

The calculated coefficients for model 2 are listed in Table no. 6. With a value of 1.472, the variable X_2 ("Product safety") has the highest coefficient among the independent variables. The independent variable X_6 ("Monthly income"), with a coefficient of 0.486, has the least impact on the logarithm of the cumulative probability. After X_2 (Product Safety), the coefficient with the highest absolute value relates to the variable X_{10} ("Blockchain Technology Familiarization"), which has a negative influence. Lesser predictor values indicate a lower likelihood of the target event occurring, whereas higher values indicate a higher likelihood.

The logarithm of the ratio of "at most" to "more than" in ordinal regression is logit, which is the difference between "the likelihood that the value of the dependent variable is less than or equal to y_j " and "the chance that the value of the dependent variable is greater than y_j ".

The basic equation of cumulative log regression:

$$\ln \left[\frac{\Pr(Y \leq y_i | X_1, \dots, X_p)}{\Pr(Y > y_j | X_1, \dots, X_p)} \right] = \alpha_i + (\beta_1 X_1 + \beta_2 X_2 + \dots + \beta_p X_p) \quad (3)$$

where:

Y - dependent variable, y_j - category j of the variable y, α_j - threshold, specific to the first k-1 values of ordinal scale, X - predictor, β - regression coefficients, specific for each independent variable, $\Pr(Y \leq y_i | X_1, \dots, X_p)$ the probability of an answer in category j or below that level.

In ordinal logistic regression, the conversion of the logit value into probabilities is done using the formula:

$$P(Y) = \frac{e^{\alpha_0 + \beta_1 X_1 + \dots + \beta_p X_p}}{1 + e^{\alpha_0 + \beta_1 X_1 + \beta_p X_p}}, \quad (4)$$

Where:

$P(Y)$ = probability of the value of the criterion, α_0 - constant (interception point), β_1 - coefficient B of the predictor X_1 , X_1 - value of the predictor 1, β_p - coefficient B of the predictor X_p , X_p - value of the predictor p

The chance ratio is calculated by taking the exponent of this coefficient: $\exp(1.472) = 4.36$, indicating that the chances of perceiving the positive effects of blockchain technology in the medium and long term “organic” food distribution chain increase by 4.36 for each unit that increases the score of variable X_2 (“Product safety”). On the contrary, we can state that for a constant change in unit of the score of the variable X_2 (“Safety of products”), the probability of perceiving negative consequences rise by $(1 / 4.36) = 0.23$.

The regression equation for those who believe that adopting blockchain technology in the medium and long term “organic” food distribution chain has negative consequences looks like this:

$$\ln \left[\frac{Prob(Y \leq 1)}{Prob(Y > 1)} \right] = -2.183 + (-1.222 * X_{10} + 1.157 * X_{11} + 1.023 * X_{15} + 0.486 * X_6 - 0.694 * X_{12} + 1.472 * X_2 + 0.776 * X_3 + 0.641 * X_{13}) \quad (5)$$

$$Prob(Y \leq 1) = \frac{1}{(1 + \exp(-2.183 - 1.222 + 1.157 + 1.023 + 0.486 - 0.694 + 1.472 + 0.776 + 0.641))} = 0.997047 \quad (6)$$

Similarly:

$$Prob(Y \leq 2) = \frac{1}{(1 + \exp(5.426 - 1.222 + 1.157 + 1.023 + 0.486 - 0.694 + 1.472 + 0.776 + 0.641))} = 0.999884 \quad (7)$$

$$Prob(Y = 1) = Prob(Y \leq 1) = 0.997047 \quad (8)$$

$$Prob(Y = 2) = Prob(Y \leq 2) - Prob(Y \leq 1) = 0.999884 - 0.997047 = 0.002837 \quad (9)$$

$$Prob(Y = 3) = 1 - Prob(Y = 1) - Prob(Y = 2) = 1 - 0.997047 - 0.002837 = 0.000116 \quad (10)$$

Conclusions and limitations

The research is constrained by the sample size and specificity; as a result, the findings must be seen in this light. Furthermore, it is restricted to the declared and specified objectives. It does, however, provide intriguing ideas and a starting point for further research. The blockchain technology has been transmitted as an innovation in order to combat the difficult food supply chain challenges when it comes to sustainability, as was emphasized by Friedman and Ormiston (2022).

These are essentially interpreted as the probability that “i” individual belongs to the category “j”, given the set of covariate variables included in the regression model.

Given the results obtained, it can be concluded that the probability that an individual will appreciate as positive the effects of using blockchain technology in the medium and long term food distribution chain is 99.705%, while the probability that an individual will remain neutral against these effects is 0.2837%. The difference, up to the unit, is the probability that an individual will appreciate the effects of using blockchain technology in the medium and long term “organic” food distribution chain as negative (0.0116%).

The results of the research show that the young age segment has a high inclination to use this technology to track the flow of food and appreciates the positive effects of using blockchain technology in the medium and long term food chain.

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