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Blockchain Technology for Efficient Management of Vegetable Oil Supply Chain

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ABSTRACT

Considering the role of new technologies and integrated information and communication technology in improving the supply chain, as well as the importance of investigating the preferences of actors to accept technology, the purpose of this study is to identify and rank the indicators of blockchain technology for the configuration of the vegetable oil supply chain. For this purpose, the symmetric analysis method was used and the relative importance of features and the desirability of evaluating parts of the surfaces were calculated. This method is used to identify and understand the combined effects of attributes on the preference for a product or service.To collect information, 9 cards were designed using XLSTAT software, and then 42 vegetable oil supply chainagents, including farmers, importers, oil factories, and other supply and distribution sectors. , completed online in 2022. Based on the results, the features of "Do the order on time & Close relationship with suppliers", "Transparency in all physical-financial-product transactions", "Reduce Lead time", "Compatibility and planning" and "Data immutability" were respectively the most desirable. This research showed that by using the features of blockchain technology, it is possible to facilitate the cooperation and integration of the vegetable oil supply chain and create the highest benefit for the chain actors. In the following, by designing the structure of this technology in accordance with the preferences of the actors of the vegetable oil supply chain and also with the cooperation of policymakers in order to plan and prepare the necessary infrastructure in order to implement blockchain technology in the country, the conditions of this chain can be improved.

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1. Introduction

Today, with the globalization of the economy and the increase in commercial competition, the importance and application of innovative methods in achieving the goals of organizations has increased and technology is introduced as one of the main factors of economic development [1]. The effects of the application of new technologies in all fields, including supply chain management, which has been facing many challenges due to its breadth and complexity, as well as facing many uncertainties, have been revealed [2 and 3].

The supply chain can be introduced as including the parts of producers, suppliers, transporters, warehouses, retailers, customers, etc., which perform activities such as new product development, marketing, executive operations, distribution, financial services, customer services, and more. In fact, the supply chain is a dynamic set of information, product and capital flows among its different levels [4]. Supply chain management is the integration of the flow of materials and goods, information and financial flow in a network of companies or organizations. Multiple partners in the supply chain need to work together to manufacture and deliver products and services to the consumer. The concept of supply chain management fundamentally changes the nature of a company, because internal business processes are no longer performed directly, but based on the integration between member organizations in the supply chain [5 and 6]. Supply chain cooperation is considered as an important factor to achieve a win-win solution for different stakeholders in the supply chain [7 and 8]. Supply chain cooperation requires a high level of commitment, trust, joint decisions and information sharing [12-9]. A high level of supply chain integration and cooperation will lead to higher levels of supply chain performance [13 and 14].

The evolution of customer demand, challenges caused by competition, geographically separated operations and the adoption of new business models (such as e-commerce), have turned the current supply chain into a completely complex system [15]. Technology has the potential to simplify the supply chain and help to perform more efficiently, but to achieve the stated goals, identifying and choosing the right technology is very important [16]. Blockchain technology is one of the emerging digital technologies with this feature that has received much attention in various aspects of the supply chain, especially the agricultural sector and the food supply chain, which is one of the most complex and largest sectors of the industry in the world [17-19]. .

Blockchain technology is a secure distributed technology and is known as a revolutionary new protocol that can transform industries, the shape and size of organizations and the way of doing business transactions, and it has attracted a lot of attention from academia and industry [20- 22 [. This technology is not only a new type of Internet infrastructure based on distributed applications, but also a new type of supply chain network that can provide a new model for future business [23-25].

Blockchain is a decentralized digital ledger that can be programmed to distribute and store data. It is also known as distributed ledger which is based on a peer-to-peer network[1] (P2P) or decentralized, which consists of a continuous sequence of blocks [26]. In other words, blockchain or block chain is a distributed database technology among members that does not depend on any centralized entity to verify transactions [27]. In a blockchain network, all parties can simultaneously share blocks and record that must be approved by all users on the network. Blocks are linked by cryptographic hash function. Each transaction can be traced by examining the block information associated with the hash keys [28-30]. In fact, blockchain is introduced with features such as transparency, speed, accessibility and immutability [31].

The review of internal studies related to the subject shows that the challenges of implementing blockchain technology have been investigated. Among these studies, we can refer to the study by Aghajanimir et al [32] who identified and prioritized the challenges of implementing blockchain technology in the supply chain using the Bayesian BWM method. Based on the obtained results, security, technical and organizational challenges were in higher priority. Also, Esmaili and Qatrami [33]

[1]Peer to Peer

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identified some challenges of adopting blockchain technology in supply chain management and classified these challenges into four groups of organizational, inter-organizational, external and technological challenges. In their study, they emphasized the need to consider the relationships between supply chain partners when adopting this technology. In another study, Abdullahi and Zoghi [34] examined the strengths of blockchain and its role in reducing supply chain management challenges. The results of their study showed that blockchain improves supply chain traceability and also reduces financial and operational risks.Also Joibar and Ebadi]35[They investigated the possibility of using blockchain in the insurance industry. Examining the capabilities of blockchain showed that this system can play a significant role by increasing accuracy and speed in the process of accepting, issuing and claiming, as well as promoting public trust in this industry. In another study, Farah Bakhsh Mohammadi [1] conducted a library study related to the relationship between blockchain technology and supply chain management performance of Iran Khodro Company.

Technology acceptance literature is defined based on technology acceptance models and their observed innovations. The review of foreign research conducted in connection with information systems shows that the technology acceptance model[2] (TAM) has been widely used [36]. In order to influence the user's attention to use technology, this method defines two focal structures "ease of use" and "usability". Also, in another study, Campbell et al. [37] used the TAM model to understand the acceptance of blockchain technology and create a desire to use it by supply chain managers. Also integrated theory of technology acceptance and use[3] (UTAUT) was used in a study focusing on the adoption of blockchain technology [38]. UTAUT identifies four key attributes including expected efficacy, expected effort, social influence and facilitating conditions that explain the user's intention to adopt an information system model.

Among other foreign studies related to the identification of blockchain features in the supply chain, we can refer to the study of Nayak and Digood [39] who presented a conceptual model of sustainable supply chain management in small and medium enterprises using blockchain technology. To develop the conceptual model of the multi-criteria decision making method[4] (MCDM) were used. They stated that the factors of competition, culture and financial constraints are among the drivers of sustainable supply chain using blockchain technology. In another study by Campbell et al. [40] 13 effective factors including traceability, retrievability and immutability using ISM methods[5] و DEMATEL[6] identified and evaluated. Identified factors were categorized based on their driving power and dependence. Saravudi [41] considering the supply chain of grape juice and applying symmetrical analysis based on rank[7], identified and ranked several potential drivers including traceability, reduction of intermediaries, transparency, coordination and control factor, compliance factor, and price for adoption of blockchain technology. Also, according to the obtained results, they presented a structure of the blockchain network.

The review of studies shows that the challenges of implementing blockchain technology and the analysis of the role of this technology in the supply chain have been considered. But it is important to note that in the first step, the acceptance of this technology should be examined. How chain actors evaluate the relative importance of different factors for technology adoption according to their supply chain needs, or to what extent such factors influence their decision-making process, should be determined [41]. In fact, there is still not much attention paid to the preferences of supply chain actors to accept blockchain technology, and this gap can be seen in studies. Therefore, the present study seeks to determine the important features of the vegetable oil supply chain for the adoption of blockchain technology and the optimal combination of these features that affect the user's choice or decision.

The supply chain of vegetable oil is very widely

[2] .Technology Acceptance Model (TAM)

[3]. Unified Theory of Acceptance and the Use of Technology (UTAUT)

[4] .Multiple-criteria Decision Making

[5] .Interpretative Structural Modeling (ISM)

[6]. Decision-making Trial and Evaluation Laboratory (DEMATEL)

[7] .Rating-base Conjoint Analysis

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used in the food industry, so that in addition to being used in other industries, due to the importance of food health, it includes a high percentage of oil consumption in food. This chain includes several links and stakeholders and complex conditions. has it. As seen in Figure (1), the vegetable oil chain includes oilseed producers, oil extraction factories, oil factories, by-products such as meal and importers, so it can be said that the vegetable oil supply chain is a traditional network of producers and suppliers. It has become a wide system of various products [43]. Currently, the purchase of oil seeds by the General Department of Grains and Commercial Services under Jihad Agriculture Organization is done from farmers as well as through imports. How to deliver products, storage, transportation and payment to farmers are among the issues that are very time-consuming in addition to damaging the quality of products. Also, to transfer to the desired factories, approval must be obtained from the specialized mother company of commercial services. This will also be time-consuming and therefore costly, because until the target factories are identified, the storage fee must be paid and the transportation must be done again. The import of oilseeds and crude oil, which actually provides a large part of the country's needs, is also facing many problems. In fact, more than 80% of the domestic oil industry's needs are supplied through imports [42]. Among these things are the amount of import, its delivery, storage and transfer, as well as currency payment by the operating banks. Delivery time, storage and transfer also face issues such as quality control, preventing illegal exchanges, etc. In addition to the issues raised, it can be said that many organizations cooperate in this chain. In order to control the quality and issue licenses, the standards organization and the food and drug organization under the University of Medical Sciences, insurance companies, transport companies, banks and the organization of industry, mining and trade are among these organizations, each of which will be involved with several issues in some way. A brief review of this chain shows the high complexity and importance of its proper management.

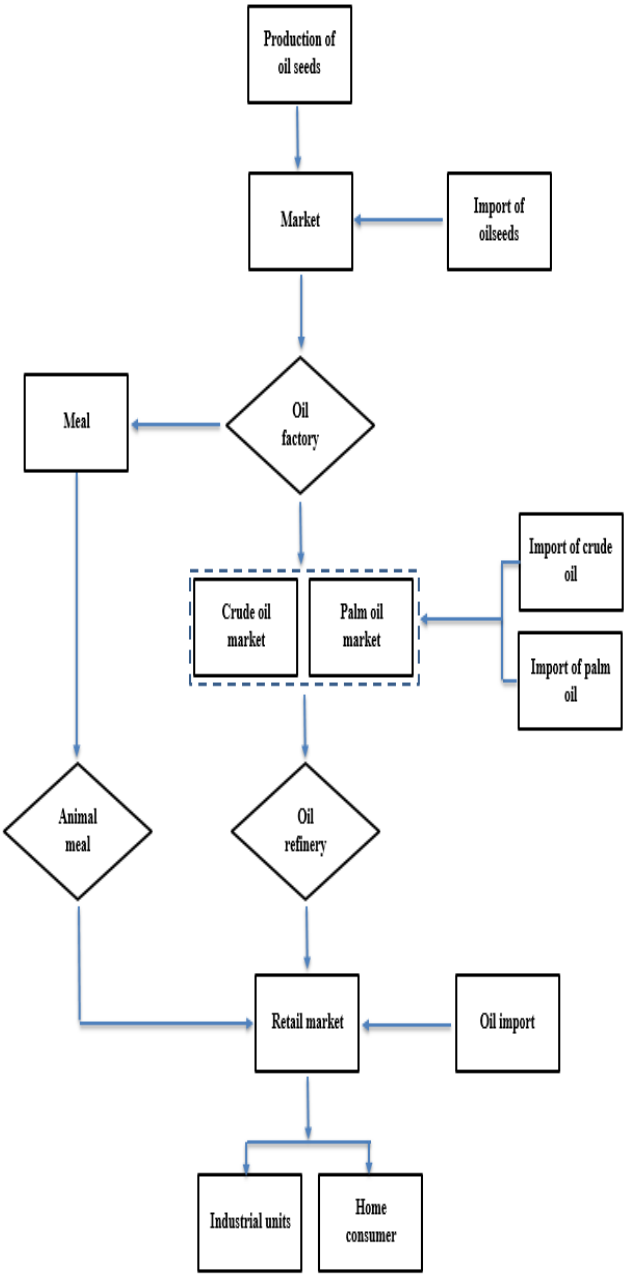

Fig 1 Vegetable oil supply chain

2- Research method

In the current research, an attempt is made to identify the factors that determine the adoption of blockchain technology for the supply chain of vegetable oil by applying the symmetrical analysis method. Transactions in such chains face important challenges such as physical and financial tracking, transparency, information security, etc. According to the investigation of the vegetable oil supply chain and the problems that

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were raised, it is possible to determine the important features of a blockchain structure for the vegetable oil supply chain. In order to achieve the goal of the present study, first, important factors related to supply chain networks equipped with blockchain technology have been identified. Then, a survey questionnaire was designed in order to collect the required information from the actors of the vegetable oil supply chain who understand the importance of technology, and finally interviews were conducted with the agents of the chain and final calculations. In the following, the symmetric analysis method and the work process will be examined separately. Also, the general work process can be seen in Figure (2).

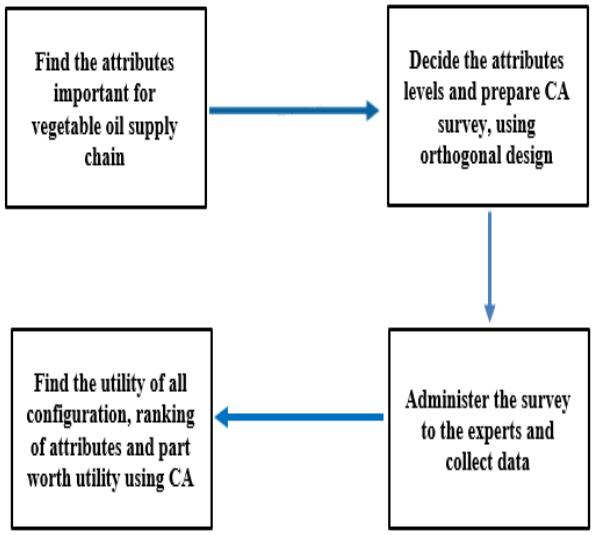

Fig 2 Flow chart describing this work

Symmetrical analysis is a method that can be used to determine how the criteria are prioritized by the respondents. In fact, this technique shows how to lighten weight options when people make decisions [44]. In the early 1970s, Green and Rao introduced symmetrical analysis to marketing research in order to understand and predict buyer behavior [45]. After that, this method has been most widely used to understand and identify the effective factors in the design of products or services in the fields of psychology and marketing, and the review of studies shows that despite the use and validity of the symmetric analysis method, its use in information systems research has been largely ignored. [46 and 47].

Symmetrical analysis method not only enables the evaluation of product features in a set of multiple indicators, but also makes it possible to define the effect of features quantitatively. The combination of selected sets of features for different respondents makes it possible to directly analyze the effect of different product features. be placed [48]. Therefore, CA has become a popular method to identify and understand the combined effects of attributes on the preference of a product or service [49].

The steps of conducting the research can be described in three parts: determining the characteristics and levels, collecting data and calculating the desirability of evaluating the part, which are as follows.

2-1- Determining the characteristics and levels of symmetric analysis

In the first step, it should be determined which features (i.e. variables) are significant for investigation and then how many features are possible to include in the study [50]. In this research, determining the characteristics by using the method of hierarchical analysis[8] (AHP), which is one of the MCDM methods, was done. This method helps to find the most appropriate answer among many different decision criteria at the same time. The proposed framework has been done using survey data collected from two sources including scientific experts from different academic disciplines as well as vegetable oil supply chain agents. Based on the results, the features of improving supply chain management, improving supply chain performance, data security and transparency in the supply chain were selected. For each attribute, a level should be defined that represents a certain

[8] .Analytical Hierarchy Process

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level of information about the attribute. to express Another, it shows what level or intensity of each of the features chain actors prefer for blockchain design. Each feature must have at least two levels and defining more levels is possible, but this will lead to an increase in the number of cards. The levels of each of the characteristics of this research were also determined based on the results of the mentioned study. The four selected features and their levels can be seen in Table (1):

Table 1 Characteristics and selected levels for technology adoption in vegetable oil supply chain

	Level 1 (Low)	Level 2 (Medium)	Level 3 (High)
Management	Order on time	Order on time & Close relationship with suppliers	Strategic planning
Performance	Reduce Lead time	Forecast	Compatibility and planning
Security	Data immutability	Secure data	Increase trust
Transparency	Transparency in physical transactions	Transparency in financial and product transactions	Transparency in all physical-financial-product transactions

Source: Research findings

2-2- Data collection

In the second stage, data collection is done by presenting the designed cards through paper surveys, online surveys or as part of structured interviews to the research participants. A software program can be used to determine the number of cards and the combination of features [50]. In the present study, using XLSTAT software, 9 cards consisting of a combination of 4 characteristics (the levels of each characteristic) were designed and online at the disposal of 42 agents of the vegetable oil supply chain, including farmers, importers, oil factories and other sectors. supply and distribution. The number of people in the sample was also determined with the help of equation (1) [51].

$$N = 500\frac{N_{lev}}{N_{alt}N_{rep}}$$

that in this regard,N_{lev} N_{lev} The maximum number of levels per feature,N_{alt} N_{alt} The number of options in each selection set andN_{rep} N_{rep} They show the number of alternatives or choice sets.

2-3- Data analysis

In the third stage, data analysis is done [50]. Basically, there are four methods of analysis in symmetric analysis: Traditional method (CA) which uses ranking of drawn cards; Choice-based hybrid analysis[9] (CBCA) which is determined based on the stated choices. Comparative linkage analysis[10](ACA) is also used if the number of features is large. The first three of these methods can be called decomposition methods because in these methods, the expressed preferences are decomposed to obtain partial evaluation utility functions. The fourth method is the combined method[11] It is called because a priority score is assigned to rank the levels of features [52 and 53]. CA is based on the hypothesis that people measure the value or desirability of a product by combining the degree of desirability provided by each feature separately. In other words, CA is a summable model in which the total utility of evaluating a part of each level is equal to the utility of all products.$U(x)U(x)$ which is obtained

[9] .Choice-based Conjoint Analysis

[10]. Adaptive Conjoint Analysis

[11]. Compositional Method

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from equation (2):

$$U(x) = \sum_{i=1}^{m} \sum_{j=1}^{k_i} \alpha_{ij} x_{ij}$$

In this regard, the total utility for a given configuration,α_{ij} Partial value utility of the level$j$ M of the feature$i$ umk_i The number of levels for the feature$i$ M. Wm Show the total number of features. alsox_{ij} It is an imaginary variable that if selected$j$ Amin property value will be one and zero otherwise.

The importance of the featureI_j As the scope of the desirability of evaluating a part in the levels of the same feature, which is shown as equation (3):

$$I_j = \{\max(\alpha_{ij}) - \min(\alpha_{ij})\}$$

$$I_j = \{\max(\alpha_{ij}) - \min(\alpha_{ij})\} \text{For each i} \quad (3)$$

In order to compare the importance of each feature to each other, the feature factor must be normalized. The importance of normalized features is calculated using equation (4):

$$W_i = \frac{I_i}{\sum_{i=1}^{m} I_i}$$

Desirability or partial evaluation desirability is also known as the degree of importance of features and the value of their levels, or simply known as the desirability of symmetric analysis, which are numerical values and measure the amount that each feature affects the decision maker's judgment for selection. The partial value of the level allows us to understand which specific level of features drives decision makers' choices.

Calculation of coefficientsα_{ij} also with the help of virtual variable regression[12]It is expressed as relation (5).

$$\sum_{i=1}^{m} W_i = 1$$

After determining the number of variables and calculating their coefficients in imaginary regression, the coefficients can beα_{ij} obtained with the help of polynomial equations.

3. Results and Discussion

The statistical population of this study includes experts and specialists active in the supply chain of vegetable oil. The sample people were selected from each of the links of the chain consisting of farmers, importers, related organizations such as the General Directorate of Grain and Commercial Services and the Organization of Industry, Mining and Trade, which are active in the distribution and supply sector, oil extraction factories and oil factories. Abstracts of statistics from sample people are presented in table (2).

Also, as stated earlier, 9 cards were designed with 4 features and the respondents viewed the cards simultaneously and chose the best type of their preference. The designed cards are provided in the attachment.

Table 2 Descriptive statistics of sample people

	Vegetable oil factory	Vegetable oil factory	Importer	Related organizations	Vegetable oil seller	Farmer
Share of the statistical population (percent)	40	19	10	19	5	7
Average activity experience (years)	13	10	7	14	11	9

Source: Research findings

Examining the completed questionnaires shows that Card 4 and Card 1 of BetterTib were the most

[12] .Dummy Variable Regression

and least popular among the respondents. It should be noted that considering that the score of 1 shows the first priority, here the lower average score indicates higher popularity. The results of the popularity check for 9 cards can be seen in Figure (3).

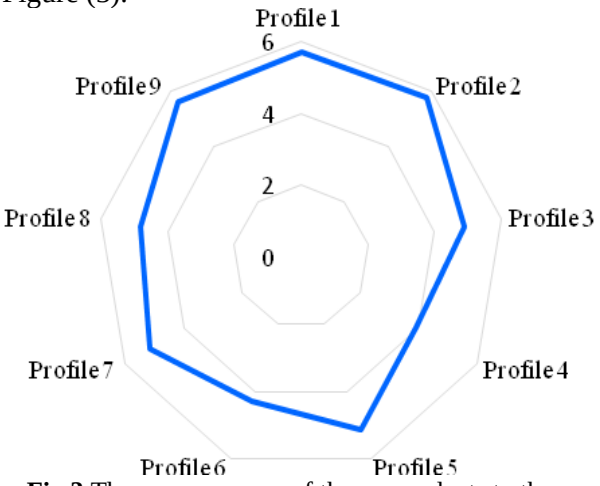

Fig 3 The average score of the respondents to the designed cards

In order to achieve the goal of determining the combination effective on the adoption of blockchain technology in the supply chain of vegetable oil, the symmetric analysis method was used and the relative importance of the features and the desirability of evaluating part of the levels were calculated. Figure (4) shows the relative importance of features including improving supply chain management, improving supply chain performance, data security, and transparency. The degree of importance is the numerical value that is attributed to each key characteristic in general. Variables with higher importance play a more important role in technology acceptance. In other words, the degree of importance of the domain is the levels of the feature that have the least choice and the levels of the feature with the most choice, and the bigger this range is, the effect of that feature on the acceptance of technology by the chain actors will be greater. Also, the degree of importance is related to desirability, and a variable with more desirability has more importance [54].

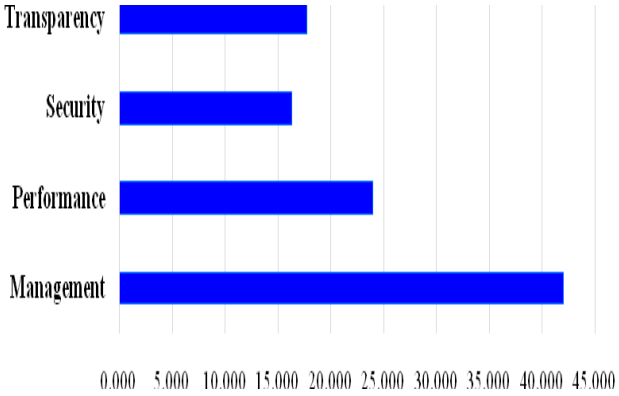

Fig 4 Importance of characteristics for technology adoption in the vegetable oil supply chain

As can be seen in Figure (4), the feature of improving vegetable oil supply chain management has the highest relative importance. Supply chain management is known as a basic principle to create a sustainable competitive advantage in the market [55]. In addition to increasing the quality of products and services, supply chain management is looking for ways to reduce the cycle of product production and providing services until they reach the customer [56]. In this way, you can take advantage of the latest advances in science and technology. Also, the features of improving supply chain performance, data security in the chain and better transparency were placed in the next categories. Performance improvement plays a key role in the success of an organization and the sustainable achievement of goals, data security means a platform for increasing data safety, fast and permanent data updating, data approval by different offices, and finally, transparency means the possibility of identifying process risks and improving chain performance. The supply and reliability of transactions refer.

As stated, the desirability of evaluating a part shows the preferences that respondents give to each level of characteristics and expresses the effect of each level of characteristics on respondents' preferences for a specific combination [57 and 58]. Higher desirability also indicates more preferences for that level of feature [59].

The positive or negative desirability is also

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interpreted according to the way the questionnaires are completed by the respondents. If the ranking method is used and the respondents sort the combinations based on their desired preference, such that the combination with the number 1 represents the highest score in terms of desirability, that is, when the respondent assigns the number 1 to a combination, this combination is the most desirable. has from the respondent's point of view. The negative sign of desirability will also indicate the reverse relationship between desirability and that feature level [54]. In this research, the ranking method was used to complete the questionnaire. The obtained results can be seen in Table (3).

Table 3 Utility of levels for technology adoption in vegetable oil supply chain

	Level	Utilities	Std. deviation
	Order on time	-0.450	1.918
Management	Order on time & Close relationship with suppliers	0.606	1.084
	Strategic planning	-0.156	2.156
	Reduce Lead time	0.122	1.268
Performance	Forecast	-0.220	1.128
	Compatibility and planning	0.098	1.263
	Data immutability	0.090	0.901
Security	Secure data	-0.085	0.908
	Increase trust	-0.005	1.027
	Transparency in physical transactions	-0.474	1.018
Transparency	Transparency in financial and product transactions	-0.005	0.894
	Transparency in all physical-financial-product transactions	0.479	0.936

Source: Research findings

Based on the results presented in table (3), the variable of timely completion of orders and close communication with suppliers, which is the second level of management characteristics, has the highest value of 0.606. Making the order on time (Just in Time), or in other wordsJust-in-time production is a comprehensive system for controlling production inventories, and in this system, no inventory of raw materials is purchased and no product is manufactured unless it is necessary. This system will result in cost reduction by eliminating warehouse inventory]60[. Today, the timely production system is known as a new thinking and attitude in the management of industrial organizations, the principles, methods and techniques derived from it result in the complete and comprehensive elimination of waste as well as increasing productivity.]61[. The second level of the management feature also refers to the close relationship with the suppliers, which makes it possible for each link to connect with its previous links in the supply chain.he does.Suppliers can have a great influence on the performance of companies in terms of price, quality, technology and delivery.

According to the obtained results, the desirability of evaluating the variable part of transparency in all physical, financial and product transactions has been calculated equal to 0.479, which is placed in the second category of the respondents' preferences. Transparency is a socio-technical factor that can be enhanced through the immutability of transactions in the distributed

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structure of the blockchain]62[. Blockchain consensus algorithm allows supply chain actors to identify process risks and improve supply chain performance and transaction reliability[41 and 15].Transparency can be defined in three levels: physical transparency, financial and product transparency, and transparency in all three situations, based on the results, transparency has been prioritized in all situations. Adaptability and planning, the third level of supply chain performance management, also show a usefulness equal to 0.098. Adaptability and planning means matching the activities of the chain with the needs of the market. Supply chain management seeks to increase adaptability and flexibility so that the ability to react and respond quickly and effectively to market changes is created. Therefore, adapting the activities of the chain to the needs of the market can lead to the improvement of the performance of the chain.

In connection with the data security feature, data immutability (first level) has been the most desirable. Due to the fact that in blockchain technology, each block contains its own hash function (unique fingerprint) as well as the hash of the previous block, which must be recalculated with every change in the block, so this technology is unhackable and this feature leads to security. Blockchain is very high in data. In traditional data management systems, validation is done by a central authority, which is often hacked and manipulated. But in the blockchain, there is no need to verify the user's permissions by the central authority, and all members of the P2P network confirm the new items added in the blockchain by adding the agreement, which makes it very difficult to manipulate the data.]63[.

Also, the first level of supply chain performance improvement has a utility equal to 0.122. Reducing lead time refers to reducing the time interval between the order of the goods and the time of receipt of the goods, and includes a set of times from the time of issuing and confirming the request to the final time of internal transportation until reaching the destination. In order to reduce the refilling time, it is necessary to carry out the operations and the time spent for each of the stages of order registration until its delivery as much as possible.

In this way, according to the obtained results, it is possible to determine the combination of levels that create the highest benefit for the agents of the vegetable oil supply chain.

Also, in order to more closely examine the preferences of different links of the chain, the desirability of oil factory agents, oil extraction factory, importers, related organizations, vegetable oil sellers and farmers were calculated separately, and the obtained results are shown in Figure (5).

Based on the obtained results,Transparency in all physical, financial and product transactions It has been the most beneficial for oil factory brokers and importers. Also, the feature of making orders on time and close communication with suppliers for brokers of oil extraction factories, related organizations and sellers of vegetable oil and for farmers, transparency in financial and product transactions.They are the first priority.

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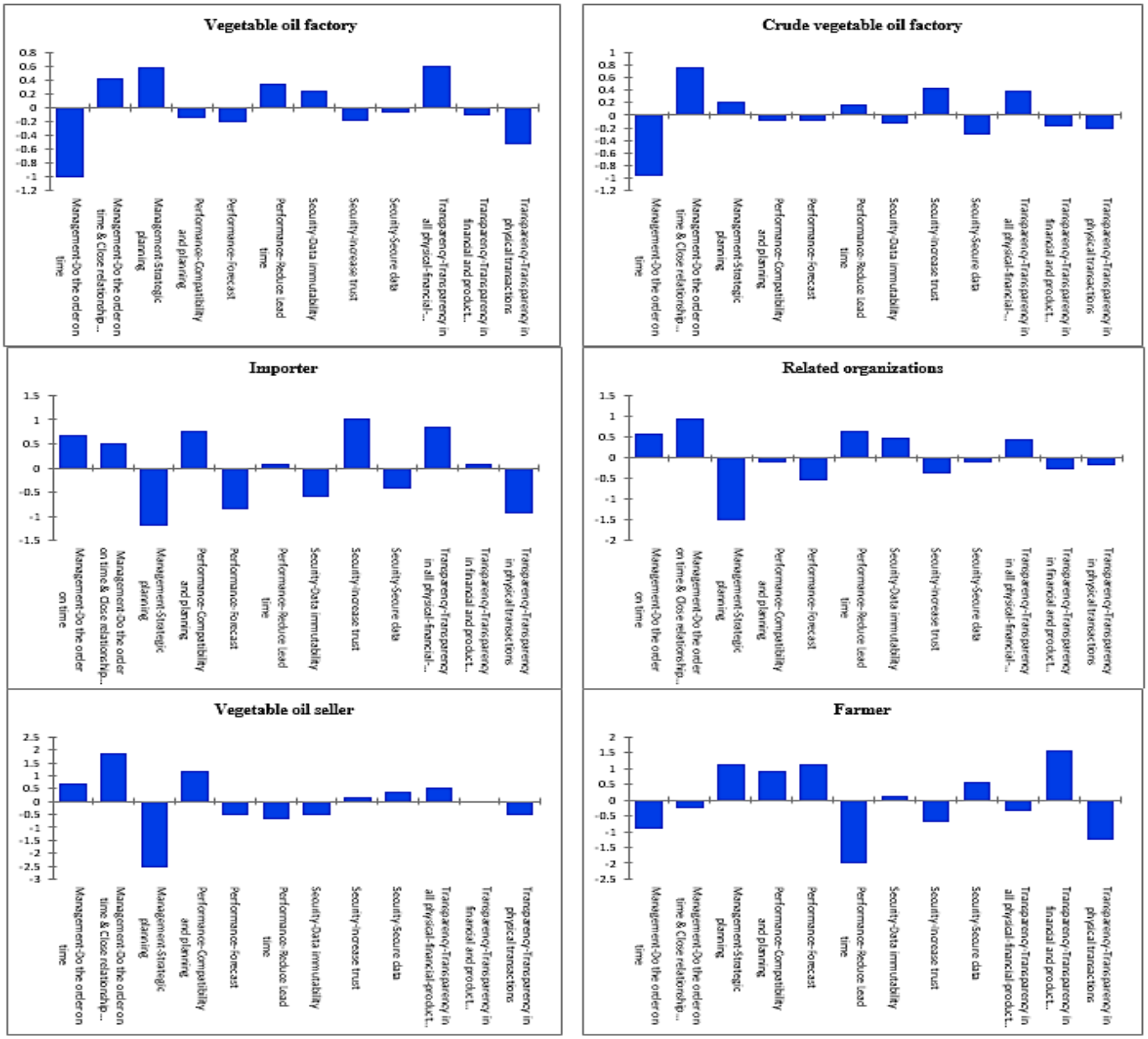

Fig 5 Utility of levels for technology adoption in vegetable oil supply chain in different groups

4- Conclusions and suggestions

Considering the expansion of the business scale, the increase of the geographical areas involved in the production process and also the variety of products, it can be said that the supply chain has changed from a traditional network of manufacturers and suppliers to a wide system of different products that is managed through several departments and Cooperation between shareholders is essential [44]. Therefore, the inclusion of modern technology in the supply chain can create better visibility and thus help companies to have better control over their business. In order for the supply chain to be flexible, innovative and transparent, it is very important to keep up with the progress of technology and maintain competition in the market [16]. Blockchain is an emerging technology that provides traceability and transparency through immutable data and trusted transactions within the chain in a decentralized manner without intermediaries or trusted third parties [64]. In recent years, this technology has been researched from various aspects, and researchers believe that blockchain will have

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great potential both in academia and industry [65]. Issues that seem to have been given less attention, especially in internal research, is the examination of the acceptance criteria of this technology by activists in various fields. In fact, before introducing this technology as a commercial solution and using it, it is necessary to know what capabilities the technology has and how it can attract the attention of activists and solve current problems. In this regard, in the present study, an attempt has been made to introduce and examine blockchain technology to the supply chain of vegetable oil. In other words, this research was carried out with the aim of identifying and ranking the blockchain technology indicators for the configuration of the vegetable oil supply chain, and the symmetric analysis method was used to achieve this goal. The proposed framework is done using survey data collected from each link of the chain including farmer, importer, related organizations, oil mills and oil refineries. Based on the obtained results, the features of "timely execution of orders and close communication with suppliers", "transparency in all physical, financial and product transactions", "reduction of replenishment time", "compatibility and planning", and "data immutability" were the most desirable. . In the researches of Al Daoud and Sadeghinsab [66] and Saurav and Day [41], the transparency factor was determined as an effective variable.

Despite the existing limitations for collecting the required data, this research showed that by using the features of blockchain technology, cooperation and integration of the vegetable oil supply chain can be facilitated and the highest benefit can be created for the actors of the chain. Among these limitations, we can mention the extent of the statistical population. The supply chain of vegetable oil includes many links with various challenges at the country level, which made it difficult to examine the preferences of brokers. Also, the lack of familiarity with blockchain technology and its advantages and applications has also been mentioned, which is a suggestion in this regard

Training courses can be held in order to familiarize supply chain agents with new technologies such as blockchain technology.

It can be stated that there are many issues that need more research and analysis to create more efficient and effective industrial applications that can benefit from blockchain technology and achieve the desired goals. Examples of these issues include security, privacy, scalability, energy issues, and integration with other systems, and more specifically with regulatory issues. Studies in this area are needed to address these issues and close the gaps for more efficient, scalable, and secure industrial blockchain applications. Is. Blockchain is an emerging technology that still many studies investigate and identify the capabilities, applications and opportunities of this technology, and despite this, it can be said that not all of its applications have been identified yet. In recent years, studies have been conducted in Iran to introduce this technology and the challenges of its application. Considering the widening of the research aspects of this technology in different fields at the global level, in this study, an attempt was made to take a step forward in domestic research. By focusing on identifying the capabilities of this technology to solve the problems and challenges in a specific field (vegetable oil supply chain) and determining the preferences of actors in this chain to accept this technology, an attempt was made to better introduce this technology and how to use it in the supply chain. To improve the conditions of the vegetable oil chain. Therefore, this study is expected to be useful as an efficient guide for further understanding of blockchain technology and its role in the supply chain. Also, with the help of the results, a blockchain structure can be designed according to the preferences of the actors of the vegetable oil supply chain, and further by programming the proposed model and also designing a smart contract, it helps to implement this technology in the vegetable oil supply chain.

5- Resources

[1] Farah BakhshMohammadi, S.K. (2021). The relationship between blockchain technology and supply chain management performance (case study: Iran Khodro Company). The second international conference on management, tourism and technology. Malaysia. 1-16.

[DOR: 20.1001.1.20088787.1401.19.133.25.0]

[DOI: 10.22034/FSCT.19.133.309]

[2] Mohammadi, A., Sahrakar, M., Yazdani, H. (2019). Investigating the effect of information technology on the capabilities and performance of the supply chain of dairy companies in Fars province: a multi-case study, information technology management. 3(8): 151-170.

[3] Manuj, I., & Mentzer, J. T. (2008). Global supply chain risk management.*Journal of business logistics*, *29*(1), 133-155.

[4] YarianTalzali, Z. and Shamsuddini, A. (2015). Supply chain integrity. The 4th International Conference on New Researches in Management, Economics and Accounting, Berlin-Germany.

[5] Lai, K. H., Ngai, E. W. T., & Cheng, T. C. E. (2004). An empirical study of supply chain performance in transport logistics. *International journal of Production economics*, *87*(3), 321-331.

[6] Porter, M. (2019). Supply chain integration: Does organizational culture matter? *Operations and Supply Chain Management: An International Journal*, *12*(1), 49-59.

[7]Ramanathan, U., &Gunasekaran, A. (2014). Supply chain collaboration: Impact of success in long-term partnerships. *International Journal of Production Economics*, *147*, 252-259.

[8] Tsou, C. M. (2013). On the strategy of supply chain collaboration based on dynamic inventory target level management: A theory of constraint perspective. *Applied Mathematical Modelling*, *37*(7), 5204-5214.

[9] Liao, S. H., Hu, D. C., & Ding, L. W. (2017). Assessing the influence of supply chain collaboration value innovation, supply chain capability and competitive advantage in Taiwan's networking communication industry. *International Journal of Production Economics*, *191*, 143-153.

[10] , J., Braziotis, C., Tannock, J. D., &Pawar, K. S. (2017). Business process management and supply chain collaboration: effects on performance and competitiveness. *Supply Chain Management: An International Journal*.

[11] Soosay, C. A., & Hyland, P. (2015). A decade of supply chain collaboration and directions for future research. *Supply Chain Management: An International Journal*.

[12] Zhang, Q., & Cao, M. (2018). Exploring antecedents of supply chain collaboration: Effects of culture and interorganizational system appropriation. *International journal of Production economics*, *195*, 146-157.

[13] Chen, L., Zhao, X., Tang, O., Price, L., Zhang, S., & Zhu, W. (2017). Supply chain collaboration for sustainability: A literature review and future research agenda. *International Journal of Production Economics*, *194*, 73-87.

[14] Wiengarten, F., Humphreys, P., Gimenez, C., & McIvor, R. (2016). Risk, risk management practices, and the success of supply chain integration. *International Journal of Production Economics*, *171*, 361-370.

[15] Zhang, J. (2019). Deploying blockchain technology in the supply chain. In *Blockchain and Distributed Ledger Technology (DLT)*. IntechOpen.

[16]Awwad, M., Kalluru, S. R., Airpulli, V. K., Zambre, M. S., Marathe, A., & Jain, P. (2018). Blockchain Technology for Efficient Management of Supply Chain. In *Proceedings of the International Conference on Industrial Engineering and Operations Management* (pp. 440-449).

[17]Kshetri, N. (2018). 1 Blockchain's roles in meeting key supply chain management objectives. *International Journal of Information Management*, *39*, 80-89.

[18] Ivanov, D., Dolgui, A., &Sokolov, B. (2019). The impact of digital technology and Industry 4.0 on the ripple effect and supply chain risk analytics. *International Journal of Production Research*, *57*(3), 829-846.

[19] Oliveira, M. P. V. D., & Handfield, R. (2019). Analytical foundations for development of real-time supply chain capabilities. *International Journal of Production Research*, *57*(5), 1571-1589.

[20]Dobrovnik, M., Herold, D. M., Fürst, E., &Kummer, S. (2018). Blockchain for and in Logistics: What to Adopt and Where to Start. *Logistics*, *2*(3), 18.

[21] Swan, M. (2017). Anticipating the economic benefits of blockchain. *Technology innovation management review*, *7*(10), 6-13.

[22] Janssen, M., Weerakkody, V., Ismagilova, E., Sivarajah, U., &Irani, Z. (2020). A framework for analysingblockchain technology adoption: Integrating institutional, market and technical factors. *International Journal of*

[DOR: 20.1001.1.20088787.1401.19.133.25.0]

[DOI: 10.22034/FSCT.19.133.309]

Information Management, *50*, 302-309.

[23] Hackius, N., & Petersen, M. (2017). Blockchain in logistics and supply chain: trick or treat?In *Digitalization in Supply Chain Management and Logistics: Smart and Digital Solutions for an Industry 4.0 Environment. Proceedings of the Hamburg International Conference of Logistics (HICL), Vol. 23*(pp. 3-18). Berlin: published by GmbH.

[24] Mansfield-Devine, S. (2017). Beyond Bitcoin: using blockchain technology to provide assurance in the commercial world. *Computer Fraud & Security*, *2017*(5), 14-18.

[25] Swan, M. (2015). *Blockchain: Blueprint for a new economy*. "O'Reilly Media, Inc.".

[26] Wang, M., Wu, Y., Chen, B., & Evans, M. (2020). Blockchain and supply chain management: a new paradigm for supply chain integration and collaboration. *Operations and Supply Chain Management: An International Journal*, *14*(1), 111-122.

[27] Sanka, A. I., Irfan, M., Huang, I., & Cheung, R. C. (2021). A survey of breakthrough in blockchain technology: Adoptions, applications, challenges and future research. *Computer Communications*, *169*, 179-201.

[28] Chen, G., Xu, B., Lu, M., & Chen, N. S. (2018). Exploring blockchain technology and its potential applications for education. *Smart Learning Environments*, *5*(1), 1-10.

[29] Zheng, Z., Xie, S., Dai, H. N., Chen, X., & Wang, H. (2018). Blockchain challenges and opportunities: A survey. *International journal of web and grid services*, *14*(4), 352-375.

[30] Zheng, Z., Xie, S., Dai, H., Chen, X., & Wang, H. (2017, June). An overview of blockchain technology: Architecture, consensus, and future trends. In *2017 IEEE international congress on big data (BigData congress)*(pp. 557-564). Yes.

[31] Apte, S., &Petrovsky, N. (2016). Will blockchain technology revolutionize excipient supply chain management? *Journal of Excipients and Food Chemicals*, *7*(3), 910.

[32] Aghajani-Mir, S.F., RajabiKashgar, F.Z. and Arab, A.R. (2021). Identifying and Prioritizing Challenges of Implementing Blockchain Technology in the Supply Chain: A Bayesian BWM Group-Based Approach. Journal of decision-making and research in operations. 6(4): 483-464.

[33] Ismaili, H. and Rajab ZadehQatrami, A. (2018). Blockchain technology in the supply chain: challenges facing the adoption of blockchain in the supply chain. The 16th International Management (Scientific-Research) Conference, Tehran.

[34] Abdullahi, A. and Zoghi, S. (2018). Blockchain and solving supply chain challenges. The second national conference on fundamental research in management and accounting, Tehran.

[35] Joibar, A.R. and Ebadi, A.A. (2019). The feasibility of using blockchain technology in the insurance industry. The fourth international conference on modern management and accounting studies in Iran, Karaj.

[36] Davis, F. D. (1993). User acceptance of information technology: system characteristics, user perceptions and behavioral impacts. *International journal of man-machine studies*, *38*(3), 475-487.

[37]Kamble, S., Gunasekaran, A., &Arha, H. (2019). Understanding the Blockchain technology adoption in supply chains-Indian context. *International Journal of Production Research*, *57*(7), 2009-2033.

[38] Francisco, K., & Swanson, D. (2018). The supply chain has no clothes: Technology adoption of blockchain for supply chain transparency. *Logistics*, *2*(1), 2.

[39] Nayak, G., &Dhaigude, A. S. (2019). A conceptual model of sustainable supply chain management in small and medium enterprises using blockchain technology. *Cogent Economics & Finance*, *7*(1), 1667184.

[40] Kamble, S. S., Gunasekaran, A., & Sharma, R. (2020). Modeling the blockchain enabled traceability in agriculture supply chain. *International Journal of Information Management*, *52*, 101967.

[41] Saurabh, S., &Dey, K. (2020). Blockchain technology adoption, architecture, and sustainable agri-food supply chains. *Journal of Cleaner Production*, 124731.

[42] Statistics of the association of vegetable oil industries, different years

[43]Aste, T., Tasca, P., & Di Matteo, T. (2017). Blockchain technologies: The foreseeable impact on society and

[DOR: 20.1001.1.20088787.1401.19.133.25.0]

[DOI: 10.22034/FSCT.19.133.309]

industry. *Computer*, *50*(9), 18-28.

[44] Hair, J. F., Black, W. C., Babin, B. J., Anderson, R. E., & Tatham, R. L. (1998). *Multivariate data analysis* (Vol. 5, No. 3, pp. 207-219). Upper Saddle River, NJ: Prentice hall.

[45] Green, P. E., & Rao, V. R. (1971). Conjoint measurement-for quantifying judgmental data. *Journal of marketing research*, *8*(3), 355-363.

[46] Bajaj, A. (2000). A study of senior information systems managers' decision models in adopting new computing architectures. *Journal of the Association for Information Systems*, *1*(1), 4.

[47] Anderson, B. B., Bajaj, A., &Gorr, W. (2002). An estimation of the relative effects of external software quality factors on senior is managers' evaluation of computing architectures. *Journal of Systems and Software*, *61*(1), 59-75.

[48] Diamantopoulos, A., Schlegelmilch, B.B., & Du Preez, J.P. (1995). Lessons for pan‐European marketing? The role of consumer preferences in fine‐tuning the product‐market fit. *International Marketing Review*.

[49] Hobbs, J. E. (1996). A transaction cost analysis of quality, traceability and animal welfare issues in UK beef retailing. *British Food Journal*.

[50] Knudsen, H. K., & Havens, J. R. (2021). Using conjoint analysis to study health policy changes: An example from a cohort of persons who use drugs. *International Journal of Drug Policy*, *98*, 103425.

[51] Johnson, F. R., Kanninen, B., Bingham, M., &Özdemir, S. (2006). Experimental design for stated-choice studies. In valuing environmental amenities using stated choice studies (pp. 159-202). Springer, Dordrecht.

[52] Green, P. E., & Srinivasan, V. (1978). Conjoint analysis in consumer research: issues and outlook. *Journal of consumer research*, *5*(2), 103-123.

[53] Green, P. E., & Srinivasan, V. (1990). Conjoint analysis in marketing: new developments with implications for research and practice. *Journal of marketing*, *54*(4), 3-19.

[54]Gustafsson, A., Herrmann, A., & Huber, F. (Eds.). (2007). *conjoint measurement: methods and applications*. Springer Science & Business Media.

[55] Faizi, A. (2017). Designing a mathematical model for planning transportation and storage of crude edible oil. Elite Journal of Science and Engineering, 3(1): 103-94.

[56] Zangui-Najad, A. (2009). What is supply chain management? Educational and Research Quarterly of Logistics Studies and Research Center, 11(27): 4-8.

[57] Krystallis, A., & Ness, M. (2005). Consumer preferences for quality foods from a South European perspective: A conjoint analysis implementation on Greek olive oil. *International Food and Agribusiness Management Review*, *8*(1030-2016-82535), 62-91.

[58] Lee, H., Rothenberg, L., & Xu, Y. (2020). Young luxury fashion consumers' preferences in multi-channel environment. *International Journal of Retail & Distribution Management*.

[59] Green, P. E., Krieger, A. M., & Wind, Y. (2004). Thirty years of conjoint analysis: Reflections and prospects. In *Marketing research and modeling: Progress and prospects* (pp. 117-139). Springer, Boston, MA.

[60] Green, K. W., & Inman*, R. A. (2005). Using a just-in-time selling strategy to strengthen supply chain linkages. *International journal of production research*, *43*(16), 3437-3453.

[61] Motfekrazad, M.A., ElahVirdizadeh, M., SoltaniGhasfandis, G. and Mehdipourmoghadam, M. (2013). Comparative study of just-in-time production components in different industrial groups of Tabriz using multivariate variance analysis, Productivity Management Journal, 8(31): 159-177.

[62] Pavlou, P. A., &Gefen, D. (2004). Building effective online marketplaces with institution-based trust. *Information systems research*, *15*(1), 37-59.

[63] Ghode, D. J., Jain, R., Soni, G., Singh, S. K., & Yadav, V. (2020). Architecture to Enhance Transparency in Supply Chain Management using Blockchain Technology. *Procedia Manufacturing*, *51*, 1614-1620.

[64] Ahmad, R. W., Hasan, H., Jayaraman, R., Salah, K., & Omar, M. (2021). Blockchain applications and architectures for port operations and logistics management. Research

in Transportation Business & Management, 41, 100620.

[65] Monrat, A. A., Schelén, O., &Andersson, K. (2019). A survey of blockchain from the perspectives of applications, challenges, and opportunities. IEEE Access, 7, 117134-117151.

[66] Al Davoud, S.A. and SadeghiNasab, M. (2021). The role of new information technologies in the development of supply chain performance of Iran's postmodern businesses. Quarterly Journal of Geographical Studies of Mountain Regions, 2(3): 82-63.

[DOR: 20.1001.1.20088787.1401.19.133.25.0]

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تکنولوژی بلاکچین برای مدیریت کارآمد زنجیره تأمین روغن نباتی

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چکیده

با توجه به نقش تکنولوژی‌های نوین و فناوری اطلاعات و ارتباطات یکپارچه در بهبود زنجیره تأمین و همچنین اهمیت بررسی ترجیحات بازیگران جهت پذیرش تکنولوژی، مطالعه حاضر با هدف شناسایی و رتبه‌بندی شاخص‌های تکنولوژی بلاکچین برای پیکربندی زنجیره تأمین روغن نباتی و مدیریت بهینه آن انجام گرفت.به این منظور از روش تحلیل متقارن استفاده شد و اهمیت نسبی ویژگی‌ها و مطلوبیت ارزیدن بخشی سطوح، محاسبه گردید. این روشبرای شناسایی و درک اثرات توأم صفات بر ترجیح یک محصول یا خدمت مورد استفاده قرار می‌گیرد. برای جمع‌آوری اطلاعات لازم، ابتدا با استفاده از نرم‌افزار XLSTAT، ۹ کارت طراحی و سپس به‌صورت آنلاین در اختیار ٤۲ کارگزار زنجیره تأمین روغن نباتی شامل کشاورزان، واردکنندگان، کارخانه‌های روغن‌سازی و روغن‌کشی و سایر بخش‌های تأمین و توزیع، در سال ۱۴۰۱ قرار گرفت. براساس نتایج به‌دست آمده، ویژگی‌های "انجام به‌موقع سفارش و ارتباط نزدیک با تأمین‌کنندگان"، " شفافیت در کلیه تراکنش‌های فیزیکی، مالی و محصول"، "کاهش زمان بازپرسازی"، "سازگاری و برنامه‌ریزی"، و "تغییرناپذیری داده‌ها" به‌ترتیب بالاترین مطلوبیت را داشتند. این پژوهش نشان داد که با بهره‌گیری از چه ویژگی‌هایی از تکنولوژی بلاکچین می‌توان همکاری و یکپارچگی زنجیره تأمین روغن نباتی را تسهیل و بالاترین مطلوبیت را برای بازیگران زنجیره ایجاد کرد. در ادامه با طراحی ساختار این تکنولوژی متناسب با ترجیحات بازیگران زنجیره تأمین روغن نباتی و همچنین با همکاری سیاست‌گذاران در جهت برنامه‌ریزی و آماده-سازی زیرساخت‌های لازم به‌منظور پیاده‌سازی فناوری بلاکچین در کشور، می‌توان شرایط این زنجیره را بهبود بخشید.