

Designing a Sustainable Competitive Advantage Model based on Blockchain Technology in the Food Industry

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Abstract

Blockchain technology is a growing digital technology and provides competitive advantage for the food industry. The aim of this conceptual and empirical study is to identify the key indicators for creating a sustainable competitive advantage in the food industry based on Blockchain technology through investigating the literature. Then, using Delphi method, the importance of each indicator is determined based on the experts' opinions. For this purpose, about 2346 online questionnaires were sent to university professors and experts in the field of blockchain. About 36 people responded to the online email and responded to the questionnaire completely. The research findings indicate that the indicators of permanent storage of information, supply chain coordination, improved performance appraisal, simplification of international transactions, traceability and fraud prevention are the top five indicators, respectively. This research helps the decision makers in the food industry to achieve a sustainable competitive advantage compared to their competitors in the market by using blockchain technology.

Keywords: Blockchain technology; Sustainable competitive advantage; Traceability; Food security; Food industry

1. Introduction

Throughout history, the food sector has faced several crises and with the increasing globalization of the market, it has become challenging to control and trust information [1]. Globalization of the food supply chain requires a high level of trust in the information systems which helps to improve food traceability. It

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is possible to track food through advanced mechanisms of information systems, but transparency and trust in information are still fundamental problems. The complexity of the food supply chain makes it increasingly difficult to detect contamination, as each food product goes through several stages within the chain [2].

The degree to which an organization combines an idea and at the same time produces a strategy that no future or current competitor can adopt is called competitive advantage. An organization is said to have a competitive advantage if an innovation strategy is not simultaneously adopted by any current competitor and is still unable to replicate the benefits of the strategy. Therefore, competitive advantage is achieved when an organization beats its competitors [3].

Tracking the origin of a product in the food chain is very difficult and time consuming process [2]. Many intermediaries have led to time-consuming and costly processes [4]. Therefore, it is necessary to create a safe framework for tracking details about the origin, adopted agricultural methods and food product safety during the supply chain without a third party or centralized control [5]. Tracking can be an effective tool for consumer protection and improving safety in food chains which can also increase consumer confidence in food safety.

Blockchain technology is one of the newest advances in technology that can improve members' confidence in the food supply chain [2]. Researchers argue that one way to solve the problem of traceability while achieving transparency is utilizing Blockchain technology. A technology that stores data in chronological order and makes it impossible to manipulate. Also, this technology allows all stakeholders to review the entire history of the product as well as its current location. This technology brings transparency to all stakeholders. According to traceability requirements of the European Union (2002) regulations, each agent must be able to track the movement of products one step forward and one step back [6].

Blockchain technology can provide an efficient solution in terms of safety and transparency if traceability of food is urgently needed. With the help of Blockchain technology, food companies can reduce food fraud by finding out quickly and connecting the disease to their resources [7]. Blockchain technology has been shown to improve tracking time so that previous tracking processes are improved from a few days to a few minutes [1].

This article identifies the key factors that can bring sustainable competitive advantage to the food industry by implementing blockchain technology. Also, conducting such research will further identify the effects of Blockchain technology on food tracking and its application in the supply chain. In this article, fifteen indicators affected by Blockchain technology leading to sustainable competitive advantage in food industry are specified through investigating the literature. These indicators are prioritized by Delphi method based on the opinions of experts. The recognized indicators include: Agricultural development,

Food security, Costs reduction, Quality improvement, Traceability and prevention of fraud, Prevention of food waste, Tracking time reduction, Simplification of international transactions, Support of company strategies, Balanced pricing process, Supply chain coordination, Improved performance evaluation, Permanent information storage, Smart contracts, Simple sell of organic products.

This research seeks to design a conceptual and empirical model to increase sustainable competitive advantage based on blockchain technology in the food industry. Also, this study explains how to achieve a sustainable competitive advantage in the food industry through the use of blockchain technology. This article provides an in-depth insight into blockchain technology and its effect on indicators that are effective in creating a competitive advantage in the food industry. The issue of sustainability is the need to pay attention to both environmental and social issues along with economic performance. Blockchain technology plays a role in improving the economy by reducing costs, storing information without changing it, increasing speed and security in transactions and transactions, reducing forgery and creating international connections. It also has a positive effect in the social sphere by increasing trust, communication, responsibility and creating profit margin through trust building. From an environmental point of view, by affecting food waste indicators, improving traceability and increasing food security leads to improvement in this field. The evaluation of sustainability indicators in the food industry is necessary, because it provides opportunities for the effectiveness of policies and actions. It also draws attention to current sustainability issues and prompts appropriate responses. Blockchain is a technology that has a high ability to solve these problems. Food companies that use Blockchain technology can gain a competitive advantage over other competitors. In fact, customers of these companies buy from these companies safely and securely, and in a fraction of a second they can identify the source of the product and all the processing performed on the product.

This conceptual and experimental research was conducted to achieve the following goals and questions:

- Introducing a method to create a sustainable competitive advantage in the field of food and agriculture industries,
- The role of blockchain in creating a competitive advantage in the basic indicators of the food industry,
- Ranking of the basic indicators of the competitive advantage of the food industry according to experts opinions,
- What is the role of blockchain technology in creating a competitive advantage in the basic indicators of the food industry?

The structure of this article is organized as follows. In the next section, the background of the literature is surveyed. In section 3, the identified indicators and their role in creating a competitive advantage are described. In section 4, the research methodology is described. In section 5, the validation of the identified indicators has been done through the Delphi study. After that, the discussion and the conclusion are presented in the section 6.

2. Research background

Wünsche et al. [8] found that blockchain technology is attracting attention because it can bring transparency to complex global food supply chains. Therefore, it has the potential to move current food production towards greater sustainability and efficiency. The results show that the benefits of blockchain technology beyond communication, reliable information and development of closer relationships between producer and consumer. Indeed, it can provide an opportunity to reduce food waste, improve working conditions across the supply chain and promote sustainable consumption habits.

Park et al. [9] focuses on supply chain management and sustainable performance in the areas of environmental protection, social equality and governance efficiency. They find that studies focusing on the impact of blockchain technology on sustainability have been steadily increasing in recent years. They also claim that blockchain platforms have a positive impact on sustainability. Blockchain technology improves waste management and ensures food safety, health and nutrition throughout the food supply chain.

Sunmola [10] in a conceptual study, examines the awareness of the context and technology of blockchain in relation to the visibility of a sustainable supply chain. The main focus of considerations is the sharing of sustainable supply chain information, auditable and mutual benefit, for distinctive vision. Therefore, in heterogeneous scenarios of the context and identification of the fundamental characteristics of the sustainable supply chain are also considered. Quality information is the key to a sustainable supply chain and information sharing is essential to being seen. Achieving good visibility requires effective management and appropriate technology, including blockchain technology.

Ali et al. [11] propose a sustainable blockchain framework for the halal food supply chain. The findings also suggest that the halal food supply chain could have a congruent and fresh perspective on the induction or replacement of blockchain technology. Also, Blockchain as malicious technology can contribute to the transparency of halal food.

Dolgui et al.[12] concluded that the applications of Blockchain technology have begun to revolutionize the various aspects of supply chain management. With the help of smart contracts, Blockchain technology provides a platform for the automatic execution of supply chain transactions.

3. Indicators affecting the food supply chain by Blockchain technology

In this section, the indicators affecting the food supply chain is identified. Focusing on these indicators will create a competitive advantage in the food industry. These indicators have been obtained through investigating the literature studies on the subject, related sites and experts in this field. We did a systematic review in the literature to identify the components and indicators needed for this research. Based on previous study, titled reviewing the impact of blockchain technology on the supply chain of meat, fruits and vegetables [13], we had a comprehensive literature review in this field. Of course, due to space limitations, we briefly explained the literature review here, the impact of blockchain technology on food is fully explained. According to those articles and the summary of literature, we found a literature gap, also according to the comprehensive and systematic review in the review article, we discovered the indicators of this research. A systematic review includes: A clear set of objectives with pre-defined eligibility criteria for studies. An explicit and reproducible method and a systematic search that attempted to identify all studies that meet the eligibility criteria. The breadth of the search in this review ensures that all research is considered, not just the most accessible or well-known works [14]. We were able to identify about 23 indicators from theoretical bases. Then, according to the experts' opinions in this field, some of these indicators were integrated with face-to-face interviews and finally reduced to 15 indicators. Figure (1) shows the conceptual model of the research indicating the recognized indicators. At the following, each indicator is described and its role in achieving competitive advantage in food industry is explained.

[Figure 1, here]

Blockchain technology is a distributed ledger that can record transactions between the two parties efficiently, permanently and globally. The concept was introduced in 2009 by Satoshi Nakamoto by introducing Bitcoin. In a Blockchain technology system, each block is identified by its cryptographic hash and is linked to others based on the previous block hash to create a chain of blocks [15]. Each block has a unique identity with unique information [16]. Blockchain technology reduces the role of intermediaries and maintains the integrity of transactions and strengthens the ability to track production and logistics

activities [15]. It is also a peer-to-peer technology that makes food trade possible in a decentralized, transparent and secure market environment [17].

- **Agricultural development**

The trade in agricultural products is an important part of the global economy. Most countries need to import and export agricultural products [17]. Forty percent of the world's income comes from agriculture, but between harvesting and selling, more than 50 percent of the value of the product is lost [18].

The distributed ledger technology provides a unique opportunity for the agricultural sector to increase trust, transparency and traceability in the exchange of value and information and productivity. It can also be profitable in the supply chains of agricultural products by eliminating intermediaries through peer-to-peer networking of transactions and smart contracts [19].

According to the transparency of Blockchain technology, farmers will be interested in providing products in this context, and the share of more profits from the product cycle will be given to them, in the long run will lead to agricultural development.

- **Food security**

Food crises have indirectly forced suppliers to use costly guarantee systems to ensure food security and meet market demands [1]. Monitoring various agricultural processes plays an important role in creating food security [16].

Security is improved with a decentralized Blockchain technology structure. Due to decentralization, network members check the validity of information based on consensus rules and this feature limits the manipulation and misuse of data [20].

- **Permanent storage of information**

When information about a process is not related to the tracking system, there is a risk of data loss [1]. Blockchain technology is a tool to ensure the longevity of records and potentially facilitates the sharing of information between different actors in a food value chain. This potential ensures transparency and trust in food chains and food supply chain integrity [21]. The permanent nature of Blockchain technology ensures that data cannot be falsified and can be used at any time in the future for analytical purposes [22].

- **Costs reduction**

Many companies have started Blockchain technology to gain a competitive advantage [23]. Blockchain technology can reduce business costs such as coordination, processing, logistics, transportation and

exchange rate costs. This is due to the possibility of automated processes and the payment and nature of decentralized, immutability and very secure. Its decentralized nature enables several institutions to take action in a safe, transparent, and real-time manner to increase efficiency [24].

- **Quality improvement**

Food quality and safety has always been a key feature of food supply chain management [25]. The food and safety crisis has caused a crisis in economic and marketing relations, both nationally and internationally [6]. A participatory tracking system with continuous monitoring leads to better control over the supply chain and product quality. It also makes it possible to identify the source faster in cases such as contaminated food [1].

Blockchain technology can include at least five aspects of a main product. These features are: Nature (what is in it), Quality (how), Quantity (amount), Location (where it is located), and ownership (the person who owns it at all times). Blockchain technology uses the tracking of existing food industry information and resources to improve food quality and safety [26].

- **Tracking time reduction**

With the prosperity of the packaged food industry, food safety accidents are increasing accordingly and consumer confidence is drastically declining. Real-time tracking and tracing is critical to ensuring the safety and quality of packaged foods [27]. By Blockchain technology, the traditional tracking documents and transportation invoices for products is performed in a fraction of seconds [28]. In the case of potential food crises, a faster tracking opportunity can not only prevent public health problems, but also provide cost-effective effectiveness for retailers [1].

- **Supply chain coordination**

The food supply chain is multi-functional and distributed around the world, and many different factors, including farmers, transportation companies, wholesalers, retailers, and food distributors, are involved [7].

To achieve efficiency and accountability, supply chain is one of the most important components. Supply chains can take advantage of modern technology to gain a competitive advantage for firms. Coordinated operations of all supply chain members using inter-organizational information of systems is a necessity. Blockchain technology provides better visibility and transaction transparency in supply chains. It is estimated that the various features provided by Blockchain technology can improve one-third of the most

common supply chain processes [22]. This technology provides a high level of process transparency and integrity in the supply chain [1].

Supply chains need transparency to provide the necessary knowledge to all factors that equalize the power of negotiation between the parties and provide more information about the origin of the product. This, in turn, can meet customer demand for more knowledge about the origin of the product and demand for sustainable transportation. Information plays an essential role in improving the relationships between actors in the supply chain because increasing the coordination of transactions can reduce costs, risks, and improve the overall competitiveness of the supply chain [29].

- **Improved performance evaluation**

Measuring supply chain management performance is often described in terms of goals such as quality, speed, reliability, cost, and flexibility. The most activities of the supply chain are affected by Blockchain technology [30].

Blockchain technology has been used to improve collaboration, trust and transparency in the food industry [31]. Transparency can activate and strengthen trust in relationships, which in turn increases performance, synergy, and overall success [1]. The main element in evaluating performance in the supply chain is transparency. Blockchain technology is superior to a centralized system for be used to clarify information disclosure. No transaction can be manipulated or changed after registering in a Blockchain technology, which increases trust [32].

- **Traceability and prevent fraud**

Counterfeit products, especially in food and pharmaceutical supply chains, can severely weaken the brand and consumer welfare. Organizations are increasingly realizing that it is essential for customers to prove their social, environmental, and sustainable credibility [31]. Deliberate manipulation of food may pose a direct health risk [28]. Knowing the source and date of consumables is an important element in combating counterfeit products. Most stakeholders have difficulty to obtain an overview of all transactions and tracking the origin of products. This leads to the emergence of counterfeit products and product quality crises that have a negative impact on the entire supply chain [33].

Tracking is the process of identifying the origin of a product, that is, reconstructing the history of the data recorded by the tracking process. By tracking a company, it can gain better control of the supply chain, and if contaminated food is available, its detection speed can be improved [6].

Traditional tracking systems have issues such as data invisibility, disclosure of sensitive information and manipulation .For food safety tracking systems, Blockchain technology is a good technology due to features such as smart contracting, consensus algorithm and unchanging time [34].

With higher traceability, food safety and integrity increase. Food companies can use Blockchain technology to reduce food fraud by quickly identifying and spreading the disease to specific sources [35,7]

- **Prevent food waste**

Food waste is a major global problem that has not only economic but also environmental and social consequences. The more food is wasted in the supply chain; the more resources are used [1].

In the supply chain, if the outbreak is due to foodborne illness, it takes several weeks to find the source of the infection [35]. In cases where food is contaminated, it is most important to find the source of the infection as soon as possible [6].

Blockchain technology makes it possible to track specific products at any given time, which helps reduce food waste [17]. The existing digital records of the product can be detected in Blockchain technology and can reveal all the cases hidden between the farm and the store, which is very helpful in food safety [35].

- **Support company strategies**

Globalization of supply chains has emerged as a business strategy to achieve a competitive advantage at lower costs, even if delivery time is longer [35]. Trust is an essential element in the successful implementation of a supply chain, especially for long-term strategic cooperation.

Successful implementation of the supply chain, for long-term strategic cooperation, requires trust. Blockchain technology facilitates business in a secure environment. Under consensus rules, transactions are approved by most participants and the need to build trust between supply chain partners is reduced [26].

Blockchain technology can be profitable for companies facing significant demand fluctuations in international transactions and that can be an effective strategic tool for companies looking to minimize lost sales [36].

- **Simplification of international transactions**

Barriers to digital commerce include security concerns and the difficulty of coordinating data flow across borders and between the parties to an international trade deal [24].

Blockchain technology has the potential to change the outlook for international trade. Blockchain technology is a database distributed from records of public or private occupations of all digital events. It allows people involved in international trade to participate in more efficient businesses by significantly reducing paper and bureaucratic interventions. International trade is defined as the exchange of goods at international borders that require time to move goods. Spending time in transportation is one of the most important barriers to trade because it is directly related to the cost of transportation [36].

Blockchain technology and cryptography enthusiasts say the technology allows customers to easily create digital identities. Blockchain technology can reduce border payment costs by simplifying access to no-bank financial services [24].

- **Simple sell of organic products**

Due to the lack of trust and the need for more transparency, many organizations are looking for certifications to be able to sell their products. These certification standards require the hearing of a large amount of product information through a supply chain by trusted third parties. However, these credentials cannot be proven to end customers due to the merely printed logo on the product packaging [35].

Blockchain technology tracking provides a clear history of the product and which is visible for buyers and therefore a high degree of confidence is achieved [26]. Obtaining a certificate for organic products is a time-consuming and costly process. Blockchain technology tracking system provides the information about the originality of the organic products which has a higher degree of confidence compared to usual certificates [32].

- **Smart contracts**

Contracts in the supply chain often include multilateral agreements and regulatory and logistical constraints [12]. In traditional supply chains driven by analog contracts, there is a pay gap between actual product delivery, invoice production, and final payment settlement.

In the field of international trade, one of the good features of Blockchain technology is the smart contract. A smart contract can take information as an input, unlike a traditional legal contract. It can also perform any agreed action by processing information through the rules set out in the contract. These conditions can include any external information such as price fluctuations, temperature and payment completion, etc [24]. Smart contracts minimize the role of intermediaries such as financial professionals and legal entities involved in the traditional contract. This separation reduces the cost of business activities and increases efficiency [26].

- **Balancing the pricing process**

Global fluctuations in distribution prices have led to an increase in consumer spending, which in turn increases the importance of improving the structure of product distribution. Consumers' need for new ways of providing information has increased. As a result, a price disclosure system has been introduced in many countries. However, distribution prices are volatile, and due to the closed and diverse performance of corporate supply chain management, the distribution structure often does not operate transparently. Since the margin price details are not specified in the distribution channel and product distribution channel, consumers are only informed of the price and origin when they purchase the product [37].

Blockchain technology can help recording price, date, location, quality, certification, and other related information for more efficient management of the digital supply network [35]. This can be a good option for farmers who have to trust marketing boards to sell their products. By eliminating intermediaries and reducing transaction costs, Blockchain technology leads to better pricing and also prevents repayment and price forced [17]. In Blockchain technology, the reputation of suppliers and identity is traced. also use smart contracts to automatically negotiate the best prices at the right time, given the seller's reputation [38]. With this technology, it is possible to prevent existing problems such as unfair pricing and the influence of large companies in pricing [7].

4. Research methodology

The research in this article is a qualitative-descriptive study and the research method used is Delphi method. The Delphi method is one of the most effective tools in the field of future research and when there is very limited information in that field. The Delphi technique is technically flexible. This method is used not only in quantitative research but also works very well in qualitative research [39]. The Delphi method is a common group technique for predicting and helping decision making based on expert opinions. It can be defined as a method of social research that aims to achieve a valid group opinion using a group of experts. This is a way to communicate between a group of people who can provide valuable assistance to solve a complex problem [40]. The characteristics of the Delphi method compared to other methods are that the production of ideas in the Delphi method is personal, unknown and independent, so the members are not affected by the pressure of the group. Second, because members do not communicate with each other, there are no problems with interpersonal and communication conflicts. Third, it is not necessary to gather members in a central location, so the costs and problems associated with coordination are less. Finally, the use of consecutive cycles in Delphi enables the observer to construct previous results and maintain his or her focus on the study [41]. The application of Delphi method is in the fields of trade, health care, education, engineering and technology, environment, information and management, leisure and tourism, social sciences and law [42]. In order to determine the specialists, a targeted and accessible

non-probabilistic sampling method is used. The study population was selected from academic experts in the fields of Industrial Engineering, Information Technology Engineering, Food industry and Management, and from experts who have worked in the field of Blockchain technology. In the field of sample size in Delphi method, 10 to 30 qualified specialists have been considered valid [43]. For this purpose, 2346 e-mails containing online questionnaire links were sent to faculty members of universities inside and outside the country and experts in the field of Blockchain technology. A total of 36 people answered the questionnaire, completely. Due to its lack of implementation in the food supply chain, we used academic experts to answer the questionnaires. The systematic review to identify indicators took three months. Also, the questionnaire was collected and analyzed within 45 days. The designed questionnaire of the Delphi study has been shown in Appendix A. The respondents have Iranian, American, Hungarian, Swiss, German, Italian, Austrian, French, Australian and Spanish nationalities, most of the respondents have Iranian nationality. The participants' specifications are shown in Table (1).

[Table 1, here]

The validity of the questionnaire has been confirmed by experts and the reliability of the questionnaire was measured by calculating Cronbach's alpha in Spss24 software. Cronbach's alpha is a popular way to measure reliability, with 0.7 being considered appropriate for Cronbach's alpha [44]. Cronbach's alpha in this study was 0.9 for 32 questions, which indicates the high reliability of the collected questionnaires. Also, to measure the importance of each indicator, some questions were raised, some of which had more than one question. After collecting the questionnaires, the importance of each indicator was determined by calculating the total average. The indicator with the highest mean was ranked higher. Indicators that had the same mean was ranked higher the indicator with the lowest standard deviation.

5. Results and findings

The research questionnaire presents some questions to measure the importance of the specified fifteen indicators based on Likert scale. In order to determine the importance and weight of each indicator, the average and standard deviation of the indicator in Excel software is calculated. First, the mean and standard deviation for each question were obtained separately, after which the total average of each indicator was calculated. The same operation was repeated for standard deviation. Table (2) shows the mean and standard deviation of the indicators.

[Table 2, here]

Table (3) illustrates the ranking of indicators based on average and absolute deviation of indicators. The indicator with a higher mean was ranked higher, and those with the same mean, the indicator with a lower

standard deviation was ranked higher. This ranking was done in order to determine the importance of indicators based on the opinion of experts. With the confirmation of the literature and experts' opinions that were considered for ranking the indicators, this table shows that blockchain technology has been able to have a positive impact on each of these indicators. This ranking was done with the aim of showing that not only the literature review indicates the positive impact of blockchain technology on these indicators, but also this positive effect has been confirmed by experts. Finally, this research introduces blockchain technology as a technology with high potential in solving the current problems of these indicators and creating a sustainable competitive advantage.

[Table 3, here]

5.1. Discussion

Table 3 shows how experts view the impact of Blockchain technology on the extracted indicators from the literature. The findings of this study deepen our understanding of the weight and importance of the effect of Blockchain technology on each indicator. Because this ranking is based on the opinions of experts in the field of Blockchain technology, it can be valid. The score (average) higher than 4 indicates the high consensus of experts about each indicator. However, other indicators, such as supporting company strategies, smart contracts, and tracking time reduction, also have a good consensus. The first is the permanent data storage indicator. According to the results, the food industry that uses blockchain technology will not lose their information, because this information is stored in blockchain permanently and without manipulation at every stage of the chain. This can strengthen trust and transparency, which are two important elements in the food industry. Due to the increasing awareness of consumers about the past, their demand for these two features is very high, and blockchain technology can largely meet this need. Another indicator of high consensus is the supply chain coordination indicator. It can be expected that the food industry that uses this technology will have a more coordinated supply chain with long-term cooperation and higher productivity. These findings also help managers to utilize Blockchain technology if they seek to globalize or Simplification their transactions, or pursue a secure tracking system. This ranking gives managers the knowledge that Blockchain technology has impact on the specified fifteen indicators, significantly. It can also be an incentive for managers to work more confidently and comfortably with the food industry that benefits from this technology.

The application of this technology in the field of food industry in the world is in its initial stages, as a result, we can find a handful of researches that have dealt with these issues. Below are some studies that have examined blockchain technology from the perspective of creating a competitive advantage in other

contexts. Bjørnstad et al. [45] have explored how blockchain, along with other resources, can help a company's competitiveness. A theoretical framework with a resource-based perspective is developed to analyze empirical data collected through a qualitative study of four blockchain companies. They found that blockchain technology is connected to other resources. Blockchain's competitiveness as a resource is reflected through the technology selection process. Their findings show that even though blockchain is a resource in itself, there are internal (knowledge of employees, entrepreneurs) and external (community and strategic partnerships) factors that make it a valuable resource for a company. Vovchenko et al. [46] found that blockchain technology implements the competitive advantages of financial contracts based on reducing the interaction costs of economic factors, providing information transparency and effective control over operational risks. Pradipto et al. [47] considered blockchain technology as a mediating variable for sustainable competitive advantage. The research was conducted in Indonesian higher education institutions in Jakarta in August 2018. They have distributed a questionnaire among 45 faculty members and active students of higher education institution. They have found that in order to gain sustainable competitive advantage, the higher education institution must apply knowledge management to survive the competition. Blockchain technology can actually become a mediating variable for knowledge management in achieving a more sustainable competitive advantage. The current research has introduced blockchain technology as a new technology to create a sustainable competitive advantage in the food industry.

6. Conclusions

Food is a multi-trillion-dollar industry, while global food supply chain networks include many layers that are functionally and geographically diverse. This study was one of the first attempts to rank several indicators using the Delphi method, which was influenced by Blockchain technology. This review has studied an important issue in the food industry and investigated the use of blockchain technology in the food industry. Most of previous studies have focused on the effect of Blockchain technology on two indicators traceability and transparency in food supply chain. This study, with a more comprehensive approach, has ranked the impact of Blockchain technology on several indicators in the food industry. Based on the research findings, it can be concluded that food industries utilizing Blockchain technology gain competitive advantage compared to competitors. The discussion of competitive advantage is the foundation and main driver for success and sustainability in the field of competition in all industries. Competitive advantage is changing over time. It is necessary to monitor the competitive advantage on a

regular basis so that in case of deviating from the right path, we can be on the right path by developing appropriate measures and planning. The increasing need of society for food and the reduction of food resources is one of the most important issues that has attracted the attention of researchers. Food industries are one of the most important and broad active industries in the global economy. Food industry lacks a sustainable competitive advantage, so we introduce blockchain technology as a solution that has a high potential to create a sustainable competitive advantage in this field. What we have found is that blockchain, with its ability to solve the problems of research indicators and improve their performance, can create a competitive advantage in the food industry compared to industries where the indicators have problems. According to experts' opinions, by Blockchain technology traceability we can track a product from its source to the dining table. It is also an effective tool that has a positive effect on many factors in the food supply chain. This indicator can have a significant impact on the food waste prevention and food safety indicator. Improving this indicator can lead to sustainable competitive advantage in the food industry. In case of presence of contaminated and perishable materials in the chain, rapid identification and improvement of its tracking capability is one of the cases that prevent further damage to the chain and wasting resources. Food waste is one of the indicators that has an environmental impact. By improving this indicator in addition to the prevention of wasting resources in food chain, more damage to the environment can be prevented. In addition to the environmental effects of this indicator, it also prevents problems arising in economic and social fields. Also, Blockchain technology through the transparency and reliable traceability, can make farmer identification easier and more convenient, and this helps eliminate intermediary brokers. The elimination of middlemen and the positive impact of yen in reducing costs from an economic aspect will greatly help the supply chain. The results of this study are expected to help managers make better decisions about using blockchain technology in the food industry. This ranking helps managers and activists in this field to plan more appropriately on indicators with higher ranks in this industry by knowing the order of their importance in the impact of blockchain technology in reducing problems and improving their performance.

From a methodological point of view, we were limited to sending questionnaires to experts. However, if this research had case-study approach for richer data, we could have seen its effects and benefits in a more objectively way. In this study, we only ranked the specified indicators. In other studies, the severity of the effect of Blockchain technology on each of the indicators and the severity of the impact of each of the indicators on each other can be examined. Managers and governments should cooperate to create institutional frameworks to create the necessary laws and policies in line with blockchain technology. More active support of managers is recommended to support the implementation of this technology in the food industry. The executive body and management of the food supply chain need to increase awareness and information in order to accept and trust blockchain technology. Considering that there is not enough

and complete information about the implications of blockchain in the food industry, it is necessary to make necessary evaluations about it before its implementation in food supply chains. This study is an incentive for managers and activists in this field to invest in the implementation of this technology.

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Captions for the Figures and Tables:

Figure 1. The conceptual framework of the study

Table 1. Specifications of experts and respondents

Table 2. Mean and standard deviation of indicators

Table 3. Ranking of indicators

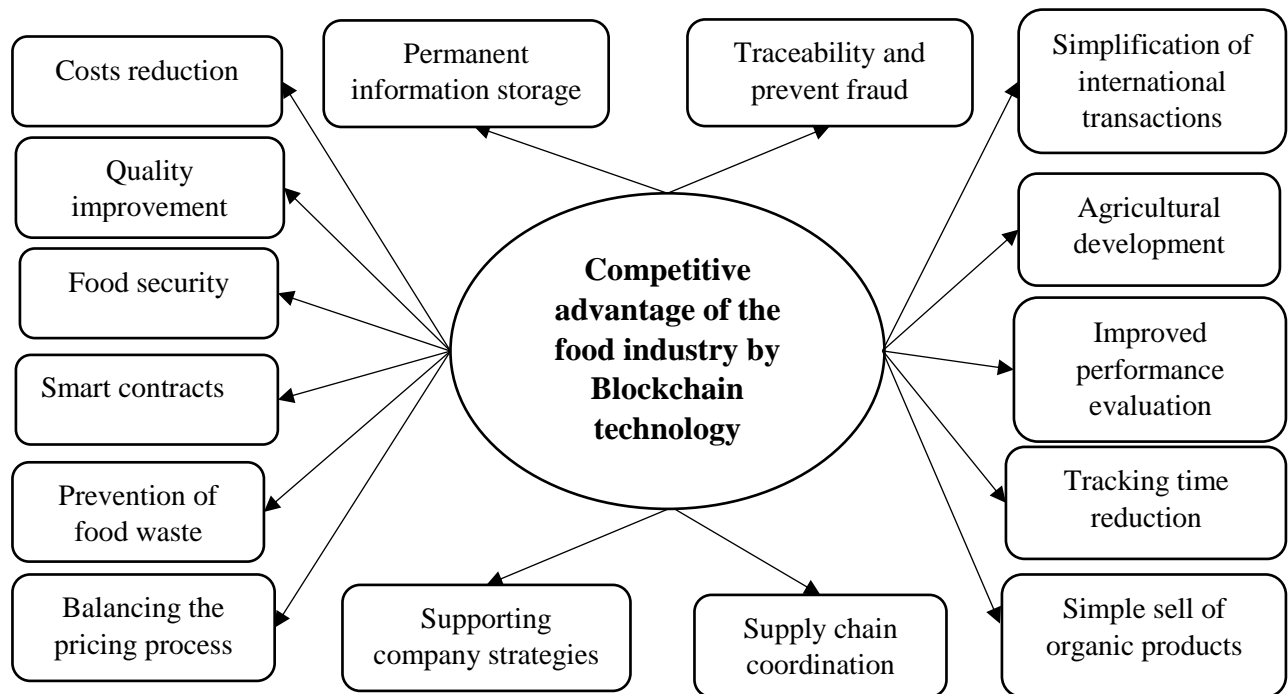


Figure 1. The conceptual framework of the study

Table 1. Specifications of experts and respondents

Variable	Group	Frequency	Percentage
Gender	Man	33	91.6
	Female	2	5.6
	Unknown	1	2.8
Level of education	Professor	1	2.8
	PhD	27	75

	Masters	2	5.6
	Bachelor's and other degrees	4	11
	Unknown	2	5.6
Working years	More than 20 years	8	22.2
	Between 10 and 20	14	38.9
	Less than 10 years	9	25
	Unknown	5	13.9
Organizational position	University professors	32	89
	Experts and managers	4	11
Nationality	Spain	1	2.8
	Austria	1	2.8
	Switzerland	1	2.8
	Hungary	2	5.5
	America	1	2.8
	Italy	1	2.8
	Germany	1	2.8
	Australia	1	2.8
	France	1	2.8
	Iran	24	66.60
	Unknown	2	5.5
Total		36 people	100

Table 2. Mean and standard deviation of indicators

Row	Influential indicators of Blockchain technology	Average		Standard deviation
1	Food security	Q1	3.77	0.94
		Q2	3.69	0.84

2	agricultural development	Q3	3.33	1.15
		Q4	3.27	1.01
3	Prevent food waste	Q5	3.44	0.89
		Q6	4.19	0.81
4	Permanent information storage	Q7	4.33	0.52
		Q8	4.11	0.99
5	Supply chain coordination	Q9	4.38	0.71
		Q10	4	0.91
6	Simplification of international transactions	Q11	4.05	0.84
		Q12	4.11	0.87
		Q13	4	0.84
7	Simple sell of organic products	Q14	3.75	0.89
8	Improved performance evaluation	Q15	4.05	0.88
		Q16	4.05	0.74
9	Traceability and prevent fraud	Q17	4	0.81
		Q18	4.25	0.68
		Q19	3.94	0.94
		Q20	3.97	0.86
		Q21	3.97	0.98
		Q22	4.22	0.58
		Q23	3.97	0.79
10	Smart contracts	Q24	3.97	0.86
11	Tracking time reduction	Q25	3.97	0.95
		Q26	3.91	0.82
12	Costs reduction	Q27	3.83	0.95
13	Quality improvement	Q28	3.66	0.91
14	Balancing the pricing process	Q29	3.58	1.01
		Q30	3.63	0.88
15	Supporting company strategies	Q31	3.38	0.97

Table 3. Ranking of indicators

Row	Influential indicators of the Chinese	Average	Standard deviation	Rank
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	block			
1	Permanent storage of information	4.22	0.75	1
2	Supply chain coordination	4.19	0.81	2
3	Improved performance evaluation	4.05	0.81	3
4	Simplification of international transactions	4.05	0.85	4
5	Traceability and prevent fraud	4.04	0.80	5
6	Supporting company strategies	3.97	0.68	6
7	Smart contracts	3.97	0.86	7
8	Tracking time reduction	3.94	0.88	8
9	Costs reduction	3.83	0.95	9
10	Prevention of food waste	3.81	0.85	10
11	Simple sell of organic products	3.75	0.89	11
12	Food security	3.73	0.89	12
13	Quality improvement	3.62	0.96	13
14	Balancing the pricing process	3.50	0.92	14
15	agricultural development	3.30	1.08	15