

Designing a food supply chain improvement model with a focus on blockchain

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Abstract

Supply chain members are interdependent through financial, material and information flows. In addition to conferring benefits for the chain, this dependence brings uncertainty and risks. The extent of such challenges makes collaborative interactions and improvement of supply chain performance confront significant problems. Therefore, managers are encouraged to embrace new technologies to settle these problems. The new blockchain technology offers advantages such as traceability, decentralization, encryption, immutability and transparency of data transfer. In this way, the things that are necessary to create trust and integrity in a supply chain are provided by a blockchain. The purpose of this study is to systematically analyze how blockchain technology is placed in the supply chain network of the food industry and present the potential challenges of its implementation. In this research, the qualitative data foundation method and MAXQDA20 software are applied to determine the antecedents and processes of blockchain deployment. In the following, the resulting paradigm model is validated using the partial least squares technique (PLS), and SMART PLS software. The results of this study indicate that the drafting of the law and the support of the government create an impact on the establishment of blockchain in the food supply chain. Moreover, with the development of technological infrastructure, the chain will be improved and ultimately gain a competitive advantage and economic development of the country even with the imposition of sanctions.

Keywords: supply chain, food industry, blockchain technology
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1 Introduction

Supply chain management as an integrated approach for proper management of the flow of materials and goods, information and cash flow, is able to respond quickly to environmental conditions. An item of goods goes through several routes in the supply chain and carries different information. Hence, it is required to have a system that can manage product information and provide the possibility to track and follow the product based on the information. In such a way that each factor of the chain can identify and track the goods in the chain due to their needs. Supply chains, especially global supply chains, are exposed to a wide range of challenges that put the performance of suppliers and the entire supply chain at risk. In general, some of the problems that exist along the supply chain are:

1. The inability to see and monitor assets from the beginning to the end of the chain.

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2. Security and fraud issues: the possibility of entering fake and invalid data in the chain.
3. Verifying the authenticity of the events in the chain: Has the goods been shipped? Has it reached its destination? Is there a charge to be made?

Considering the mentioned problems, companies should improve their management strategies to respond quickly to unexpected events in the supply chain; to diminish the adverse effects of such challenges [3]. When the disruption risk occurs, the designed supply chain network should be able to respond to customers' needs as the destructive effects of disruption risks will increase when the products are fast-moving consumer goods. Fast-moving consumer goods (FMCG) include food, detergents, and some medicine; increasing the inventory level of such goods will lead to three consequences at the supply chain level: first, it makes different parts of the supply chain face the financial loss caused by product deterioration. Disposal of perishable product waste and its impact on the environment is the second challenge. The third challenge is the process of reducing the quality of perishable goods that starts from the production time. In such a situation, food supply chain management is very important to ensure the quality, safety and freshness of products [57].

To meet the challenges of the supply chain industry, especially the food chain, blockchain technology can be adopted as a growing and better alternative to centralized databases such as product storage and tracking. Due to the ability to increase the level of information integration throughout the supply chain and between different factors, blockchain technology can increase the transparency and efficiency of the supply chain and positively affect all sectors from warehousing to delivery and payment. The features of this technology increase trust through transparency and traceability in any transaction data of goods and financial resources [48] as it is a large ledger that records all transactions made by users [28, 39].

In this research, an attempt has been made to introduce blockchain as a new technology and its effect on the food supply chain. This research describes the existing concepts and studies in the field of blockchain technology in the food supply chain and tries to investigate the factors affecting the establishment of blockchain technology and the benefits of this technology. The structure of this research is as follows: literature review is given in Section 2; in Section 3 the research methodology is described; and finally, the research ends with future research direction and conclusions in section 4.

2 Literature review

To examine the latest state of research in the literature and the trend of researchers' attention to the topic of blockchain, articles published in nine scientific databases have been studied. The results illustrate that a large part of research has been published since the first half of 2018, due to the rapid development of blockchain technology, which indicates the novelty of the subject. For instance, the terms supply chain and blockchain have been mentioned as keywords in approximately 1,500 articles, of which about 1,060 researches have been conducted in 2018, and it clearly demonstrates the exponential growth of blockchain research in the supply chain. The purpose of this section is to present different researches and views about blockchain technology in different fields, especially the food supply chain.

2.1 Blockchain technology

Blockchain is a distributed database where data is shared over a peer-to-peer network. The network members are the nodes that communicate with each other, and the data follows a predetermined protocol without a central authority; moreover, it maintains a continuously-growing list of data records, that refers each of them to the previous items in the list. Thus, a means of dealing with undermining or unauthorized revision is reinforced [35, 47]. Blockchain was created using cryptography where each block (transaction) has an encrypted hash and is linked to the previous block. When a block is confirmed by a certain percentage of network nodes, it is added to the previous block and forms a blockchain [13]. In blockchain, data is converted into digital codes and stored in a shared database and is somehow immutable.

Blockchain has a digital record with every agreement, payment and transaction activity. These records may be authentic and shared among individuals and organizations. Intermediaries like brokers, bankers, and lawyers are less needed [33]. Transparency, lower risk of fraud, instant transactions, security and privacy, assurance of financial data are among the advantages of blockchain technology [18]. Blockchain facilitates secure online transactions and is a decentralized and distributed digital ledger that allows participants to review and audit transactions at low cost [2, 45]. The use of blockchain eliminates the feature of infinite multiplication of a digital asset. Exchange based on it, can be done faster, more conveniently and cheaper than traditional systems. Blockchain technology usually includes the following capabilities that may depend on the platform used [9]:

- Shared ledger: A data structure that is locally distributed and shared between different participants.
- Authorization: safe and valid transactions that guarantee data security and transparency.
- Smart contracts: business terms embedded in the database executed with transactions.
- Consensus: Transactions confirmed by key users that guarantee data immutability and traceability.

Blockchain is currently gaining attention in various industries: finance [1], healthcare [21], real estate and energy markets, public services, and the government sector [12]. Blockchain in finance has provided active applications such as tokens, initial coin offerings, smart contracts, market prediction systems, and cryptocurrencies [7]. One of the sectors of blockchain that receives more attention than other sectors is the supply chain. Safety, quality, accessibility, and data documentation are among the success factors of blockchain in the supply chain [53].

2.2 The application of blockchain in the supply chain

Blockchain technology strives to pave the way for smart grids to move data, which can significantly make supply chain management more productive and transparent. Therefore, several companies have either already started implementing this technology or are currently considering it to improve the quality of their business [55]. The majority of scientific articles that examine the potential of blockchain technology to support supply chain management demonstrate four main themes: trust, trade [44], technology [5], and traceability/transparency [37].

Chang and Iakovou provide an overview of how blockchain technology can improve global supply chain issues such as transparency, dispute resolution, compliance, integrity, and stakeholder management. Transparent information that tracks the origin of materials and products, supply chain members, processes, and operations shared on the blockchain ledger can enhance product provenance, chain of custody and authenticity [54]. They have investigated important role of the factors that lead to the integration of blockchain with the supply chain. Data security and decentralization, accessibility, rules and policies, documentation, data management, and quality can fac strategy with blockchain [4]. As a result, they reach the conclusion that blockchain is an effectual technology as it causes more data sharing among supply chain members.

From these researchers' perspective [19, 40], the most significant factors affecting the implementation of blockchain in the supply chain are: discovering the current information flow of the chain (confidentiality and trust, information sharing, data standardization) and determining new goals to improve the flow of information in the supply chain (improving the flow of data, building trust by establishing security).

Blockchain can provide many benefits for the supply chain, some of the most important of which are:

- Smart contracts: One of the first steps that enable supply chain activities is to make the contract. The formation of a "smart contract" by a computer protocol provide the facilitation, verification, or enforcement of contractual obligations [16]. It can transparently facilitate the exchange of money, real estate, or anything of value while reducing the costs associated with intermediaries. Such contracts ensure that everyone will be settled on time. In addition, they have sufficient funds available for projects [22]. Smart contracts help companies access real-time data, market shares, consumption patterns, and manage consumer spending [56].
- Error-free asset and order tracking: Blockchain allows its user to track and trace the entire path from the origin of an asset. In this way, blockchain not only prevents counterfeit assets from being traded but also makes it easier to track goods as they move through the chain [32]. Companies have automated all their processes to avoid order delays and eliminate mistakes. Moreover, they have increased significantly the number of jobs and distributors in the supply chain [41].
- Cyber Security: The increase in digital data and the expansion of Internet companies means that there is a higher risk of an attack on their database. Hackers may intend to modify, steal or delete data [11]. Blockchain is defined as a cryptographic protocol of value [6].

2.2.1 Food supply chain

With an estimated population of 9.7 billion by 2050, achieving food security is a considerable challenge. Food security is defined as a state in which "all people, at all times have physical and economic access to sufficient, safe and nutritious food that meets their dietary needs and food preferences for an active and healthy life" [23]. The causes

of food insecurity are multifaceted and arise from social and economic inequalities as well as environmental disorders [46].

One of the specific challenges of the industry is managing the supply chain of fast-moving consumer goods since food and pharmaceutical products may have a very short life cycle. Furthermore, the routing from the factory to the distribution centers can be delayed, which will apply a lot of pressure on cost-effectiveness due to the competition in the market. Blockchain addresses issues such as food traceability, supply chain transparency, and environmental impact [25].

Blockchain can identify counterfeit products in pharmaceutical supply chains. It enables origin tracking in food supply chains to overcome the challenges of foodborne disease outbreaks, and it facilitates sensor-equipped cargo status checks in supply chains with the help of IOT [29]. Blockchain can be used to improve the management, food safety, and quality in dairy supply chain [50] as traceability increases the efficiency of the supply chain [38] and minimizes the risks that reduce food quality and safety [51].

Bumblauskas [10] conducted research with the aim of implementing blockchain technology in the production chain delivery system and egg supply from the farm to the consumer. The introduction of blockchain in the food supply chain allows consumers to accurately track the food chain [4]. Blockchain is introduced and modeled as a support solution for food and agriculture traceability [27]. He concluded that support and development of blockchain technology applications, as part of a digitalization strategy, is to improve transparency, efficiency competitiveness and sustainability of the agricultural sector.

Despite the general acceptance, blockchain facilitates controllable interactions and enables the exchange of immutable data between supply chain partners. Adopting this technology and creating supply chain transformation is a time-consuming process. Currently, most blockchain applications are conceptual and empirical evidence on their implementation is limited [26]. Besides, few studies have been conducted on the challenges of blockchain deployment in the supply chain, like organizational readiness, technical expertise, scalability, and compatibility with existing systems. The novelty of this research is to focus on the use of blockchain in the food supply chain, which is one of the most important topics in recent years and has not been addressed in the literature so far.

In this research, an attempt has been made to introduce blockchain as a new technology and its impact on the fast-moving consumer goods supply chain, which requires the attention of researchers and experts. Therefore, this research study presents the deployment model of blockchain technology in the FMCG supply chain network and provides the challenges of its implementation. In the research process, this issue will be feasible and the aim of this article is as follows:

- Identifying the antecedents of blockchain deployment in the food industry.
- Identifying factors interfering with the establishment of blockchain in the food industry.
- Identifying the results of blockchain deployment in the food industry.

3 Methodology

This section describes the methods employed in analyzing the data to answer the research questions. The first step is the method and type of research. The second step includes the population, sample and sample size, the methods, and tools of information gathering. In final step the method of data analysis is stated.

This study, based on the objective, is exploratory research as it seeks to design an optimization model for a food supply chain with a focus on blockchain. On the other hand, due to the fact that library study methods and field methods such as semi-structured interviews and questionnaires were applied in this study, it can be acknowledged that the current research is considered a cross-sectional study based on the data collection method. This research is based on qualitative and quantitative approaches. First, based on library research and expert interviews, the indicators of the optimization model for a food supply chain with a focus on blockchain are identified. After the qualitative analysis stage, the questionnaire is distributed and data is collected from the selected experts, and the research enters the quantitative phase. So, the present study is considered as mixed methods research. The research implementation algorithm is shown in 4.

3.1 Data collection

The main data collection tools are library research, semi-structured interviews, and researcher-made questionnaires.

Library research: First, to study the theoretical issues related to the purpose of the research and review the literature on the subject and its background, the information available in specialized books and articles about the optimization model for a food supply chain with a focus on blockchain has been utilized.

Semi-structured interview in qualitative analysis: Second, to gain knowledge and understanding of the optimization model for a food supply chain with a focus on blockchain, as well as more coordination and recognition of research variables with some blockchain experts, university faculty members, and activists in the food industry in-depth interviews have been conducted.

Quantitative analysis questionnaire: After identifying the primary indicators, the final validation of the model is carried out using a questionnaire based on a five-point Likert scale. Managers, marketing officials, business stakeholders, and primary or effective stakeholders in financing and trade in the field of food supply chain are the target population in the quantitative section.

First, we collect qualitative data to shape the conceptual model. Qualitative data is collected based on an open questionnaire. In an open questionnaire, there are no options or suggestions for questions. The respondent constructs their own response without being given any options. In the stages of designing a questionnaire to measure the research model, attempts are made to verify the research tool according to 3 types of validity (content, representation, and structure). To evaluate the content validity, frequent indicators confirmed in the past research have been used in setting up the questionnaire. This research was conducted from August 2021 to August 2022. The method of collecting answers to questionnaires is in the form of in-person interviews, telephone interviews, postal questions, or sending and receiving the questions in the form of letters, and internet questionnaires.

3.1.1 Population, samples, and data collection in the qualitative stage

We requested collaboration for data collection from university professors, blockchain experts, industrialists, policy makers, raw material suppliers, and food industry activists in the qualitative section. In studies conducted with qualitative research method and interviews, the most common sample size is between 5 to 25 participants. To select industry experts, three suggested criteria [8, 31] have been followed. (1) position and responsibility in the company, (2) knowledge and experience in the desired field, and (3) willingness to participate. All selected experts have had at least 10 years of experience in supply chain management.

The research population can be classified into two general groups: 1) academic professors, and 2) food industry activists. In fact, the sampling method in this research is a combination of non-probability targeted (judgmental) sampling and snowball sampling. The reason for using purposeful non-random sampling - judgmental sampling in this research is that we select the participants who provide us with the best and required information [34, 43]. Experts have a greater understanding of situations and more experience and knowledge about cause-and-effect relationships than novices. Therefore, they generally provide us with more insightful, deeper and more acceptable opinions [20, 36].

The reason for using the snowball sampling method in this research is that this method is employed when there is no sampling frame; on the other hand, the sampled participants would likely know each other in the same situation as themselves and could inform others. In this sampling method, the researcher can preferentially select the samples that have a greater familiarity with the research subject. Grounded technique has been used to present the research model which is extracted from experts' opinions as Grounded Theory can be used for "identification" and "screening" of the most important decision-making indicators. Since Grounded Theory, which can be utilized for "identification" and "screening", is the most significant decision-making indicator, we have used this technique to present the research model extracted from experts' opinions.

Table 1 shows the demographic characteristics of the experts participating in the interview by gender, age, education and work experience.

3.1.2 Population, samples, and data collection in the quantitative stage

To determine the sample size, the simplest method is to use Cochran's formula. This formula is one of the widely used methods for calculating the statistical sample size in the world.

In this research, Cochran's formula has been applied to calculate the sample size of food industry customers, due to its unlimited nature. In this formula, p is the estimated proportion of the variable attribute using previous studies and $1 - q = p$. If p is not available, it can be considered 0.5. Z is also equal to the reliability coefficient and a 95% confidence level gives us Z values of 1.96. d , which is the acceptable margin of error in the survey research, is generally considered between 0.05 and 0.2, which is 0.05 in this study. The nature of Cochran's formula is such that for the high volume of the population the required sample size is 380 to 384. For instance, if the sample size changes from

Table 1: Demographic characteristics of experts

Demographic characteristics		frequency	percentage
Gender	male	9	100%
	female	0	0%
Age	up to 35	2	22.22%
	up to 45	3	33.33%
	55 and above	4	44.44 %
Education	Masters	3	33.33%
	PhD	6	66.66%
Work experience	5 years	1	11.11%
	10 years	1	11.11%
	15 years	5	55.55%
	15 years and above	2	22.22 %
Total		9	100%

30 thousand to 3 million participants, the sample size will change from 380 to 384 participants. We use the formula $n = \frac{z^2 pq}{d^2}$, where n is the population size, z is the standard error percentage of the acceptable reliability coefficient, p is the estimated proportion of the population with a certain trait, q is a proportion of the population without a certain trait and d is degree of confidence or possible accuracy. As there is no accurate information about the population size, the expression (1) has been used:

$$n = \frac{z^2 pq}{d^2} = \frac{(1.96)^2 (0.5)(0.5)}{(0.05)^2} = \frac{0.9604}{0.0025} = 384.$$

Therefore, 384 questionnaires are randomly distributed among the customers of the food industry. In Table 2, the demographic characteristics of the clients participating in the interview are presented by gender, age, education and work experience.

Table 2: Demographic characteristics of clients

Demographic characteristics		frequency	percentage
Gender	male	244	64%
	female	140	36%
Age	30 to 40	115	30%
	40 to 50	179	47%
	Above 50	90	23%
Education	Masters	60	16%
	PhD	208	54%
	Postgraduate	116	30%
Total		384	100%

3.2 Data analysis method

3.2.1 Qualitative analysis

In the first stage, we conducted the qualitative research method of database or Grounded Theory, which has been acclaimed as one of the most important strategies of qualitative research. The Grounded Theory method determines, analyzes and expresses the main categories of the studied phenomenon. This method organizes qualitative data and describes it in detail. MAXQDA software was used for qualitative analysis.

Our data analysis was guided by the Grounded Theory method of Strauss and Corbin approach and it is shown in the figure 1. This type of analysis is done through 3 types of coding. Open coding, axial coding and selective coding [49]. Open coding: This stage involves categorizing different codes into potential themes and sorting all coded data summaries into identified themes. In (Appendix 4) the open coding of the interview texts is presented. Axial Coding: The second stage is the analysis of data in Database Theory. It is the process of relating categories to subcategories and linking the categories at the level of their characteristics and dimensions [42]. At this stage, we categorize the indicators extracted from the interview texts by screening, removing duplicate codes, and integrating synonymous codes. The relationship of other stages with the axial Code stage can be realized in six categories, which are causal conditions, main phenomenon, strategies and actions, intervening conditions, contextual conditions, and consequences [49]. Axial coding is shown in Table 3.

Selective coding: In this stage, the coder selects a category of the central coding stage and places it in the under-review center of the process under the title of "central phenomenon" and then relates other categories to it. Other

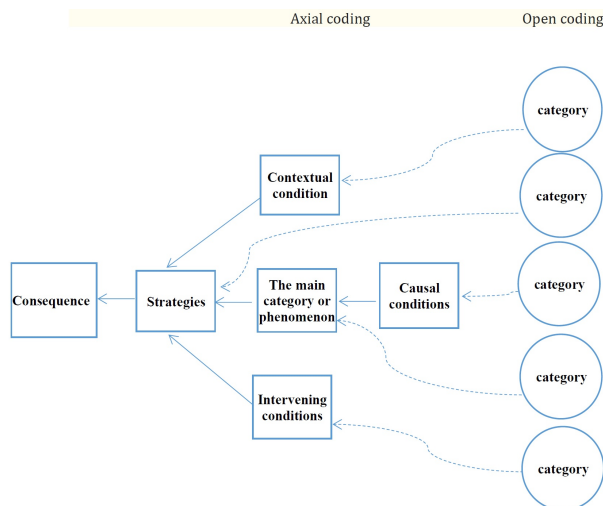


Figure 1: Grounded Theory method

categories include causal conditions, contextual conditions, phenomenon-oriented conditions, intervening conditions, strategies and actions, and consequences. According to the opinion of professors and experts, 50 indicators have been used to design the optimization model for a food supply chain with a focus on blockchain. The research paradigm model is shown in Figure 2.

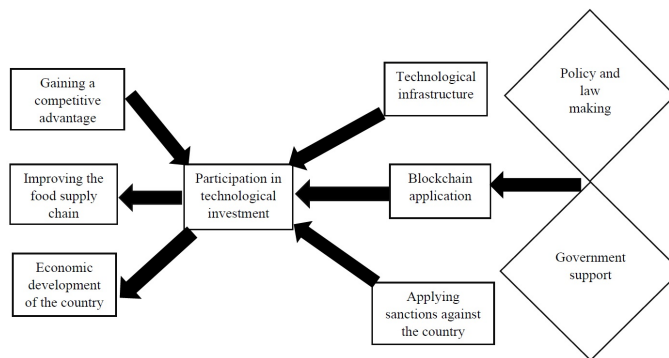


Figure 2: Research paradigm model

3.2.2 Quantitative analysis

To validate the model Partial Least Squares (PLS) technique has been applied. The results of using the model in the standard estimation mode show the direction and intensity of the relationship between the variables. The output of Smart PLS software for standard estimation is presented in Figure 3. To check the significance of the relationships of the model variables, the Bootstrap method has been employed, which provides the t statistic. At the 5% error level, if the value of the Bootstrapping statistic is greater than 1.96, the observed correlations are significant. The t statistic and Bootstrapping value to measure the significance of relationships are shown in Figure 4.

In PLS models, when the sample size is diminutive, or the distribution of variables is not normal, two models are tested: outer models and inner models. The outer model is similar to the measurement model (confirmatory factor analysis). Moreover, the inner model is the same as path analysis in structural equation models (SEM). After testing the outer model, it is required to present the inner model that shows the relationship between the variables of the research. We can test the research hypotheses of the model, by using the inner model.

Outer Model

This part of the model shows that the items intended to measure each of the main factors have sufficient validity. The relationship strength between the items and the factors related to their effectiveness and significance is measured by the t-statistic. The results of the outer model are presented in Table 4.

Table 3: Axial coding

Subcategory	Main categories	Dimensions
1. Upgrading software and hardware infrastructure	Technological infrastructure	Contextual condition
2. Boosting cybersecurity		
3. Applying the Internet of Things (IOT) and anti-hacking the route		
4. Updating equipment and facilities based on modern technology		
5. Increasing the technical knowledge of human resources in the field of blockchain (technology adoption)		
6. Establishing governance rules and roadmap	Policy and law making	Causal conditions
7. Establishing a governing and reference organization for Processing and issuance		
8. Reducing administrative bureaucracy		
9. Establishment of social responsibility supporting producer and consumer	Government support	
10. Facilitating regulatory compliance		
11. Acquiring knowledge and awareness of the rules		
12. Creating a codified and comprehensive national land use document		
13. Utilizing the country's potential and capacities		
14. Identifying and supporting existing talents and potentials	Blockchain application	Main phenomenon
15. Determining the integrated custodian regulatory bodies		
16. Product process management and control		
17. Implementation of the requirements and standards of the country		
18. Fair pricing		
19. Food traceability throughout the supply chains from farm to consumer		
20. Reducing rent and preventing fraud		
21. Creating an indelible and secure record		
22. Simplifying domestic and foreign (international) transactions with minimum cost		
23. Simplifying domestic and foreign (international) transactions with minimum fee		
24. Supply chain alignment and transparency	Participation in technological investment	Strategies and actions
25. Facilitating the sale and delivery of products		
26. Emphasizing the importance to the R&D area		
27. Bringing different investors into the cycle		
28. Showing profit margins to investors		
29. Encouraging and motivating investors and producers	Applying sanctions against the country	Intervening conditions
30. The need for quality standards to store data in the blockchain		
31. Lack of access to modern production technology		
32. Importing raw materials, parts and counterfeit products	Improving the food supply chain	
33. Lack of distribution databases		
34. Enhancing food safety, standard and quality		
35. Reducing waste production and recycling materials		
36. Increasing the health and safety of food		
37. Environmental Protection		
38. Creating value through the clarification of the production process till the consumption of the product		
39. Reduce latency and increase reliability		
40. The extent of the target markets and their achievement in a short time	Gaining a competitive advantage	Consequence
41. Developing customer trust		
42. Improving efficiency and productivity		
43. Reducing transaction costs and product development		
44. Increasing competition and variety of products		
45. Reducing the number of intermediaries in the network		
46. Alignment of economy and health through safe food basket	Economic development of the country	
47. Growth of national production and investment		
48. Helping to develop business		
49. Increasing profit and continuity in the consumer's shopping basket		
50. Ensuring customer sustainability and the interests of stakeholders		

The values of the factor loadings are greater than 0.5 and the t statistic is greater than 1.96. Therefore, the outer model is approved. Four indicators are used to evaluate the validity of the outer model: convergent validity, composite reliability, Cronbach's alpha, and discriminant validity. Composite reliability (CR) in structural models is considered a more valid measure than Cronbach's alpha (α) because in the calculation of Cronbach's alpha for each structure, all indicators are included in the calculations with the same importance. However, in calculating the combined reliability of indicators with higher factor loadings, it is more significant and makes the CR values of the constructs a more accurate measure than Cronbach's alpha. For convergent validity and combined reliability, $CR > 0.7$; $CR > AVE$; $AVE > 0.5$ should be established. Table 5 shows that AVE is greater than 0.5. Therefore, there is convergent validity. Cronbach's alpha of all variables is greater than 0.7, so the reliability is confirmed. In all cases, CR is also greater than AVE , and it is greater than the threshold of 0.7. As a result, the third condition is also fulfilled.

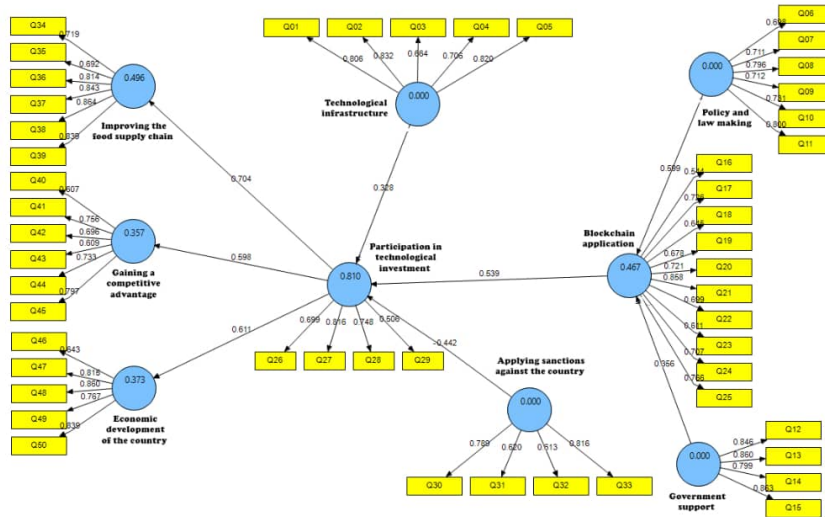


Figure 3: Model validation output with partial least squares method

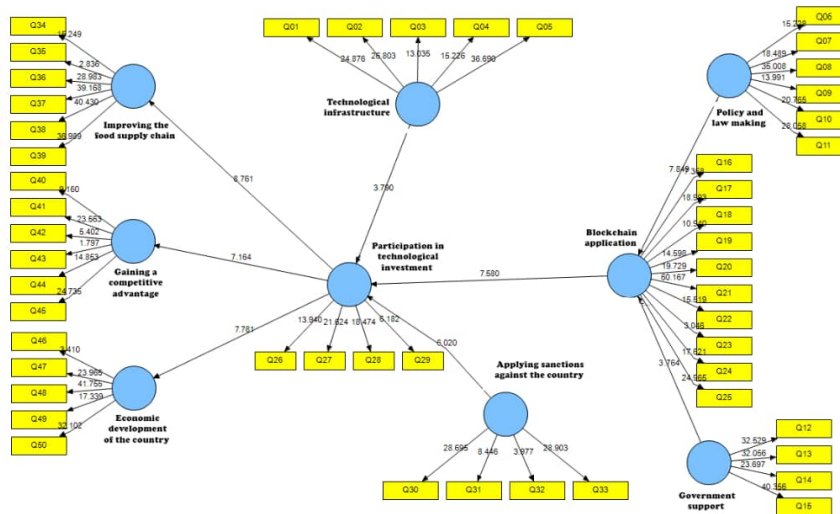


Figure 4: Significance of variable relationships with partial least squares method (Bootstrapping)

Discriminant validity refers to the low correlation of the items of a latent variable with other latent variables. Based on the proposed method [24], discriminant validity is acceptable when the square root of AVE of each construct is greater than the correlation between the construct and any other construct in the model. In the PLS method, this is done by a matrix that contains the values of the correlation coefficients between the constructs and the main diameter of the square root matrix of the AVE values of each construct. As shown by Table 6, the square root of AVE reported for each construct (principal diameter) is greater than its correlation with other constructs of the model, which indicates acceptable discriminant validity for measurement models.

Inner model

The relationships between the main constructs of the research are examined in the structural section and based on the influence coefficient and the value of the t statistic, the relationships of the variables are presented in Table 7.

In the Partial Least Squares technique (PLS), effect size index f^2 , coefficient of determination R^2 , predictive correlation index Q^2 and Goodness-Of-Fit index (GOF) are usually used to evaluate the structural part. R^2 and Q^2 are used to measure the predictive power of the model. These two indicators are calculated for endogenous variables. The indicators of the predictive power of the model are reported in Table 8. R^2 represents the proportion of the variance for a dependent variable explained by independent variables. The higher the coefficient of determination of endogenous structures of the model, the better the model fit. Three values of 0.19, 0.33, and 0.67 are used as the

Table 4: Outer model result

Main categories	Items	Factor loading	t statistic
Technological infrastructure	Upgrading software and hardware infrastructure (Q01)	0.806	24.876
	Boosting cybersecurity (Q02)	0.832	26.803
	Applying the Internet of Things (IOT) and anti-hacking the route (Q03)	0.664	13.035
	Updating equipment and facilities based on modern technology (Q04)	0.706	15.226
	Increasing the technical knowledge of human resources in the field of blockchain (technology adoption) (Q05)	0.820	36.69
Policy and law making	Establishing governance rules and roadmap (Q06)	0.698	15.228
	Establishing a governing and reference organization for Processing and issuance (Q07)	0.711	18.489
	Continuous monitoring and solving administrative bureaucracy (Q08)	0.796	35.008
	Establishment of social responsibility supporting producer and consumer (Q09)	0.712	13.991
	Facilitating regulatory compliance (Q10)	0.731	20.765
Government support	Acquiring knowledge and awareness of the rules (Q11)	0.800	28.058
	Creating a codified and comprehensive national land use document (Q12)	0.846	32.529
	Utilizing the country's potential and capacities (Q13)	0.860	32.056
	Identifying and supporting existing talents and potentials (Q14)	0.799	23.697
	Determining the integrated custodian regulatory bodies (Q15)	0.863	40.356
Blockchain application	Product process management and control (Q16)	0.544	7.358
	Implementation of the requirements and standards of the country (Q17)	0.726	18.993
	Fair pricing (Q18)	0.645	10.94
	Food traceability throughout the supply chains from farm to consumer (Q19)	0.678	14.598
	Reducing rent and preventing fraud (Q20)	0.721	19.729
	Creating an indelible and secure record (Q21)	0.858	60.167
	Simplifying domestic and foreign (international) transactions with minimum cost (Q22)	0.699	15.519
	Simplifying domestic and foreign (international) transactions with minimum fee (Q23)	0.611	3.046
	Supply chain alignment and transparency (Q24)	0.707	17.621
	Facilitating the sale and delivery of products (Q25)	0.766	24.965
Participation in technological investment	Emphasizing the importance to the R&D area (Q26)	0.699	13.94
	Bringing different investors into the cycle (Q27)	0.816	21.624
	Showing profit margins to investor (Q28)	0.748	18.474
	Encouraging and motivating investors and producers (Q29)	0.506	6.182
Applying sanctions against the country	The need for quality standards to store data in the blockchain (Q30)	0.789	28.695
	Lack of access to modern production technology (Q31)	0.620	8.446
	Importing raw materials, parts and counterfeit products (Q32)	0.613	3.977
Improving the food supply chain	Lack of distribution databases (Q33)	0.816	28.903
	Enhancing food safety, standard and quality (Q34)	0.719	15.249
	Reducing waste production and recycling materials (Q35)	0.692	2.846
	Increasing the health and safety of food (Q36)	0.814	28.983
	Environmental Protection (Q37)	0.843	39.168
	Creating value through the clarification of the production process till the consumption of the product (Q38)	0.864	40.43
Gaining a competitive advantage	Reduce latency and increase reliability (Q39)	0.839	36.989
	The extent of the target markets and their achievement in a short time (Q40)	0.607	9.16
	Developing customer trust (Q41)	0.756	23.563
	Improving efficiency and productivity (Q42)	0.696	5.402
	Reducing transaction costs and product development (Q43)	0.609	1.797
	Increasing competition and variety of products (Q44)	0.733	14.853
Economic development of the country	Reducing the number of intermediaries in the network (Q45)	0.797	24.735
	Alignment of economy and health through safe food basket (Q46)	0.643	3.41
	Growth of national production and investment (Q47)	0.815	23.965
	Helping to develop business (Q48)	0.860	41.775
	Increasing profit and continuity in the consumer's shopping basket (Q49)	0.767	17.339
	Ensuring customer sustainability and the interests of stakeholders (Q50)	0.839	32.102

criterion values for weak, medium, and substantial R^2 values in the structural part of the model [15]. If the value of Q^2 is positive, it indicates that the model has strong predictive power [30].

Table 5: External validity of research constructs

Main structures	AVE	CR	α
Applying sanctions against the country	0.561	0.764	0.789
Improving the food supply chain	0.571	0.881	0.829
Blockchain application	0.563	0.892	0.863
Policy and law making	0.551	0.880	0.838
Economic development of the country	0.563	0.857	0.776
Government support	0.709	0.907	0.864
Technological infrastructure	0.591	0.878	0.826
Participation in technological investment	0.513	0.791	0.746
Gaining a competitive advantage	0.530	0.782	0.794

Table 6: Discriminant validity assessment matrix

Research structures									
Imposing sanctions on the country (1)	0.749								
Improving the food supply chain (2)	0.217	0.755							
Application of blockchain (3)	0.630	0.297	0.750						
Law making and policy making (4)	0.540	0.344	0.586	0.742					
Economic development of the country (5)	0.358	0.142	0.178	0.307	0.750				
Government support (6)	0.429	0.317	0.391	0.671	0.618	0.842			
Technological infrastructures (7)	0.579	0.272	0.619	0.483	0.226	0.375	0.769		
Participation in technological investment (8)	0.401	0.345	0.474	0.419	0.168	0.323	0.434	0.716	
Gaining a competitive advantage (9)	0.300	0.301	0.255	0.214	0.187	0.268	0.371	0.153	0.728

Table 7: Results of the structural part of the model (relationships of model variables)

Relationship	Influence coefficient	t statistic	Result
Law making and policy making → Application of blockchain	0.599	7.849	confirmed
Government support → Application of blockchain	0.356	3.764	confirmed
Application of blockchain → Participation in technological investment	0.539	7.580	confirmed
Technological infrastructures → Participation in technological investment	0.328	3.790	confirmed
Imposing sanctions on the country → Participation in technological investment	-0.442	6.020	confirmed
Participation in technological investment → Improving the food supply chain	0.704	8.761	confirmed
Participation in technological investment → Gaining a competitive advantage	0.598	7.164	confirmed
Participation in technological investment → Economic development of the country	0.611	7.781	confirmed

Table 8: Prediction power of the model

Main structures	R^2	Q^2
Improving the food supply chain	0.496	0.262
Blockchain application	0.667	0.183
Economic development of the country	0.373	0.158
Participation in technological investment	0.810	0.364
Gaining a competitive advantage	0.357	0.080

As illustrated by results of Table 8, the coefficient of determination of the endogenous structures of the research model is favorable. The value of the coefficient for determining the improvement of the food supply chain is 0.496, the economic development of the country is 0.373, and the gaining a competitive advantage is reported as 0.357, which is an acceptable value. This reveals that the variables of the model have been able to explain 54% of the changes in machine learning. The predictor correlation index was also obtained positive in all cases, so the model has strong predictive power. The effect size analyzes the relationship between dependent and independent variables. In fact, this index shows what changes will be made in the dependent variable if an independent variable is removed. Values of 0.02, 0.15, and 0.35 indicate the small, medium, and large effect sizes [17]. As shown in Table 9, the effect size is estimated to be medium to large; it is more than 0.02 in all cases.

The GOF index measures the fit of the overall model of the structural part. Three values of 0.01, 0.25 and 0.36 have been introduced as small, medium and large values for GOF [52]. GOF has been obtained equal to 0.556; the model has a proper fit.

Table 9: Effect size of research constructs

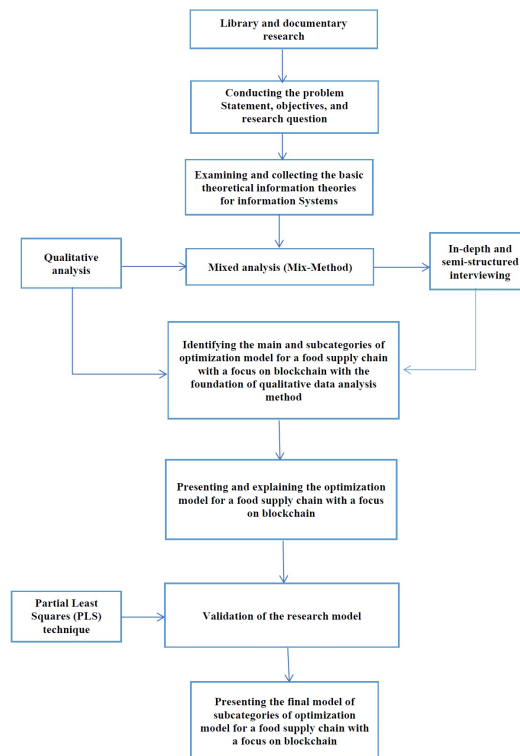
Relation	f^2
Law making and policy making → Application of blockchain	0.560
Government support → Application of blockchain	0.145
Application of blockchain → Participation in technological investment	0.409
Technological infrastructures → Participation in technological investment	0.121
Imposing sanctions on the country → Participation in technological investment	0.243
Participation in technological investment → Improving the food supply chain	0.683
Participation in technological investment → Gaining a competitive advantage	0.557
Participation in technological investment → Economic development of the country	0.596

4 Conclusions and recommendations for future research

In this research, a new model of blockchain application in the food supply chain is proposed. The purpose of this study is to identify the antecedents, intervening factors and consequences of the adoption of blockchain deployment in the food industry. This study is one of the first attempts to investigate the cause-and-effect relationships of indicators in this field. Our findings showed that out of all the indicators obtained from the qualitative analysis foundation data of interviews, 50 indicators have been used to design the optimization model for a food supply chain with a focus on blockchain. The most urgent challenges are the cooperative participation of the government and law making that are effective in the implementing this technology. Due to its nature, blockchain requires considerable computing power and internet connection bandwidth, which with the development of technological infrastructure, increased participation and investment, which, despite the sanctions against the country, the ability to gain competitive advantage; ultimately, the economic development of the country due to the optimization model for a food supply chain.

The present research was carried out in the food industry which is one of the pioneering industries of the country. Other industries including automotive, petrochemical, electronics, and defense industries can also obtain benefits from the results of this study; try to use the benefits of this technology in their supply chain. Adding new components and dimensions to the variables in the supply chain of other industrial fields and examining the model with a larger statistical population are proposed as recommendations for future research.

Appendix 1



Appendix 2

Table 10: Initial (open) coding of the text of the first interview

Code	Segment	Area	Coverage%
Forward and back-up in the back and front chains (Interview 1, Pos. 6)	The food chain is a set of forward and back-up involved in the backward and forward supply chains.	91	2.40
The production chain has relationships with the exploitation system (Interview 1, Pos. 6)	It starts from the suppliers of raw materials before the production of the product until it reaches the production chain that includes the relations of the exploitation system.	126	3.32
Product production of raw material suppliers (Interview 1, Pos. 6)	It starts from the suppliers of raw materials before the production of the product until it reaches the production chain that includes the relations of the exploitation system.	126	3.32
Per capita section of packaging and storage and... and distribution	The exploitation system of production cooperatives of agricultural companies and industries and the per capita sections of packaging and storage, etc., and the next part of the chain is the distribution section.	149	3.93
The exploitation system of production cooperatives of agricultural and agriculture companies	The exploitation system of production cooperatives of agricultural companies and industries and the per capita sections of packaging and storage, etc., and the next part of the chain is the distribution section.	149	3.93
warehouse systems (Interview 1, Pos. 8)	Its warehouse systems and ... form a set of supply chain.	63	1.66
The possibility of tracking with new technology (Interview 1, Pos. 11)	This tracking is possible with new technology.	39	1.03
Product story line (Interview 1, Pos. 12)	It helps the consumer to understand the story line of the product.	56	1.48
Determining the history of the product in clean product production (Interview 1, Pos. 12)	In clean product production, the history of the product is determined from the origin to the destination.	64	1.69
Specific and evolving platforms	These things happen on platforms that are evolving day by day. And the quality features will also be specified in this platform.	122	3.22
Determining the authenticity of production for the consumer (Interview 1, Pos. 13)	For example, where is saffron being produced, which substrate and what inputs are used to create it, and this way the authenticity of the production becomes clear for the consumer and creates value.	144	3.80
Creating value through the clarification of the product production process (Interview 1, Pos.)	In the past, these parameters were not considered in production systems, but nowadays they have been taken into consideration by the consumer and the producer can create value by clarifying the product production process. For this reason, companies are willing to move in this direction.	233	6.14
Increasing profit and continuity in the consumer's market basket.	To get a more reliable profit through clean production and continuity in the consumer's market basket.	79	2.08
Increasing customer information about their consumer products	When customers have more information about the product, they are using.	68	1.79
Influencing the customer's living standards (Interview 1, Pos. 17)	It affects their living standards.	52	1.37
Consumption of healthy products by smart consumers (Interview 1, Pos. 17)	Naturally, they tend to consume healthy products, and the consumer is not a normal consumer, but an intelligent consumer who lives at a higher level.	140	3.69
The impact of the blockchain environment in pre- and post-production (Interview 1, Pos. 19)	The blockchain environment has both post-production and pre-production effects.	56	1.48
Creating transparency and trust through blockchain space (Interview 1, Pos. 19)	The blockchain space creates a kind of trust through the transparency.	66	1.74
Specifications of agricultural inputs for crop production (Interview 1, Pos. 19)	For instance, it specifies the specifications of agricultural inputs for product production, so the producer cannot use every seed and every input.	134	3.53
The requirement to use high quality inputs (Interview 1, Pos. 19)	And the producer is forced to use high quality inputs. On the other hand, he does not use any kind of fertilizer. He cannot use any pesticide. In this way, he supplies raw materials from reliable suppliers.	193	5.09
The usefulness of the blockchain environment for consumers and producers	The blockchain environment can be very effective for both producers and consumers.	71	1.87
Reducing the market margin by the blockchain environment (Interview 1, Pos. 19)	The blockchain environment reduces the margin of the market. Instead of brokers, we have blockers or suppliers will have an effective performance.	120	3.16
Bringing different investors into the cycle (Interview 1, Pos. 20)	On the other hand, it brings different investors into the cycle, something that does not exist in the traditional supply chain.	88	2.32
Creating a revolution in the supply chain (Interview 1, Pos. 20)	It can revolutionize the supply chain.	43	1.13

Showing the profit margin to investors (Interview 1, Pos. 21)	It can show the profit margin to the investor.	45	1.19
Determining safe profit margins (Interview 1, Pos. 21)	Determine the safe profit margins.	32	0.84
Product price stability (Interview 1, Pos. 22)	The removal of middlemen through the communication and internal connection of the supply chain with blockchain technology leads to product price stability.	107	2.82
Eliminating middlemen through communication and internal supply chain connectivity	The removal of middlemen through the communication and internal connection of the supply chain with blockchain technology	73	1.93
A fair price for the producer and a good price for the consumer	Usually, these margins of the market are removed and it causes a fair price for the producer and a suitable price for the consumer.	108	2.85
Eliminating market margins (Interview 1, Pos. 22)	Usually, these margins of the market are removed and it causes a fair price for the producer and a suitable price for the consumer.	108	2.85
The impact of technology on distribution networks (Interview 1, Pos. 23)	This technology is also effective for distribution networks.	43	1.13
Lack of distribution databases (Interview 1, Pos. 23)	As we do not currently have distribution databases.	48	1.27
Ensuring the stability of the customer and the benefit of the beneficiaries (Interview 1, Pos. 23)	And databases that can build trust can build customer sustainability and benefit supply chain stakeholders.	107	2.82
Databases that create trust (Interview 1, Pos. 23)	Databases that can build trust can create customer sustainability and benefit supply chain stakeholders.	104	2.74
Product forecasting by supply chain stakeholders (Interview 1, Pos. 23).	And the stakeholders of the supply chain can make the necessary forecasts for the supply and production of the required goods.	106	2.80
Identification of target customers (Interview 1, Pos. 24).	In this way, they can identify target customers.	52	1.37
Determining the selective quality of goods (Interview 1, Pos. 24).	That these customers determine the target of selective product quality.	53	1.40
Feeding the market in different time frames and sending coordinated signals.	The same thing happens in the storage system. In warehousing, it can feed the market in different time frames and respond to demand and signals in one piece.	148	3.90
warehouse system (Interview 1, Pos. 24)	The same thing happens in the warehouse system. In warehousing, it can feed the market in different time frames and respond to demand and signals in one piece.	148	3.90
Determining the amount of stock and sales by blockchain environment	Therefore, the blockchain environment tells you how much to store and how much to sell so that the price does not fluctuate.	90	2.37
Possibility of control (Interview 1, Pos. 26)	The blockchain environment gives you control.	37	0.98
Increasing system resilience and business intelligence	And increases the resilience of the system. It is a kind of commercial intelligence	64	1.69

Table 11: Initial (open) coding of the text of the first interview

Code	Segment	Area	Coverage%
Forward and back-up in the back and front chains (Interview 1, Pos. 6)	The food chain is a set of forward and back-up involved in the backward and forward supply chains.	91	2.40
The field of food as the first item of the first development plan	The first item of the first development program is the food sector.	49	1.92
Providing food and healthy food for the community	It is important that we provide both food and healthy food for the society.	74	2.91
Food health and safety (Interview 2, Pos. 6)	The health and safety of food is an important issue that starts from the farm to the consumer's table.	83	3.26
Supervision of the Ministry of Health (Interview 2, Pos. 6)	The Ministry of Health is monitoring this issue.	37	1.45

Failure to consider international standards in the country	Despite international standards, chemical fertilizers and pesticides are not taken very seriously in our country, and large-scale products have definitely been genetically manipulated.	127	4.99
Genetic manipulation of large-scale crops (Interview 2, Pos. 6)	And large-scale crops have definitely had genetic manipulation.	51	2.00
The manufacturer's requirement to use quality raw materials (interview 2)	This recognition forces the manufacturer to use quality raw materials.	74	2.91
Creation of a national land preparation document in a codified and comprehensive manner (Interview 2, Pos)	We do not have a codified and comprehensive national land preparation document	50	1.96
Utilizing the country's potentials and capacities (interview 2)	We do not utilize the country's potentials well.	64	2.51
Lack of coordination of needs with production	Requirements are not aligned with production.	28	1.10
Lack of coordination of the production of some products with the country's geography and economy	On the other hand, the production of some products is not in harmony with the country's geography and economy.	65	2.55
Identifying and supporting talents and potentials (Interview 2, Pos. 9)	Identifying and supporting talents and potentials.	40	1.57
The customer's right to choose according to the budget (Interview 2, Pos. 11)	The consumer has the right to choose according to his budget.	46	1.81
Misinformation is as deadly as malnutrition (Interview 2, Pos. 11)	Misinformation is as deadly as malnutrition.	49	1.92
Motivating the producer	The producer becomes motivated.	33	1.30
Fair pricing	To make the price fair.	23	0.90
Clarify and create trust and acceleration in the supply chain	This clarification causes trust and acceleration in the supply chain.	60	2.36
The effect of transparent supply chain on production health	Due to the use of many non-standard poisons and fertilizers to increase production, and the presence of lead and heavy metals in food, if this continues, people will buy poisons and diseases instead of buying food. A transparent supply chain can affect production health to some extent.	273	10.72
Presence of lead and heavy metals in food (Interview 2, Pos. 13)	Due to the use of many non-standard poisons and fertilizers to increase production, and the presence of lead and heavy metals in food, if this continues, people will buy poisons and diseases instead of buying food. A transparent supply chain can affect production health to some extent.	273	10.72
Using a lot of non-standard poisons and fertilizers for production	Due to the use of many non-standard poisons and fertilizers to increase production, and the presence of lead and heavy metals in food, if this continues, people will buy poisons and diseases instead of buying food. A transparent supply chain can affect production health to some extent.	273	10.72
Fair pricing on products	When a product is removed from the agricultural land, there is little profit for the producer and 90% of the profit is for the middlemen. Blockchain helps to put a fair price on the products.	173	6.79
Land use (Interview 2, Pos. 17)	It is one of the items of land use	38	1.49
Determining the amount of product production in different departments (Interview 2, Pos. 17)	A transparent cycle helps to determine the amount of product production in different sectors	64	2.51
Identifying the talents of different environments (Interview 2, Pos. 17)	The talents of different environments should be identified.	36	1.41
Smart supply chain and prevention of product depots (Interview 2, Pos. 18)	If the supply chain is smart, product depots in the capital will be avoided.	68	2.67
Reducing costs and facilitating the sale and delivery of products	When a product is removed from the agricultural land, there is little profit for the producer and 90% of the profit is for the middlemen. Blockchain helps to put a fair price on the products.	80	3.14

The elimination of product corruption and its disposal (Interview 2, Pos. 18)	It is one of the items of land use is a safe territory.	71	2.79
Reducing the time to access products (Interview 2, Pos. 18)	A transparent cycle helps to determine the amount of product production in different sectors	44	1.73
Reduction of agricultural production (Interview 2, Pos. 20)	The talents of different environments should be identified.	91	3.57
Planning for product production (Interview 2, Pos. 20)	If the supply chain is smart, product depots in the capital will be avoided.	55	2.16
Measuring products needed by customers (Interview 2, Pos. 20)	And measure the required products and also the needs of customers.	63	2.47
Increasing trust between customers and sellers (Interview 2, Pos. 20)	If a product does not have a customer, it should be specified. It also increases trust between customers and sellers.	88	3.46

Table 12: Initial (open) coding of the third interview text

Code	Segment	Area	Coverage%
Necessity of informing about agricultural products in the supply chain	Information about agricultural products in the food supply chain is part of the necessities.	81	7.31
Insertion of product information by food and drug manufacturers (interview 3, Po)	Food and drug manufacturers should be required to include information on the package.	73	6.59
The importance of the type of product offered to the customer	In e-business, it is very effective to know what we offer to the customer.	87	7.85
Creating a competitive advantage (Interview 3, Pos. 5)	Does it create a competitive advantage?	29	2.62
Business improvement (Interview 3, Pos. 5)	Supply chain improves business.	38	3.43
Combining quality with customer demands (Interview 3, Pos. 5)	Quality is combined with customer demands.	35	3.16
Influence on product transparency (Interview 3, Pos. 5)	And it has a great effect on product clarity.	39	3.52
Consumers aware of their health needs (Interview 3, Pos. 7)	A consumer who is aware of his health needs	44	3.97
A consumer who is not aware of his health needs	A consumer who is not aware of his health needs.	46	4.15
Estimating the criterion of product selection by the consumer	We must know what criteria the consumer who buys the product considers.	72	6.50
Price, health and transgenic product	Is the price reasonable, is the food healthy? Is the product genetically modified or not?	65	5.87
A society with people who are aware of their needs	In a society where people are aware of their needs, they will definitely buy healthy and non-GMO products.	99	8.94
Importance of product price and lack of importance to food health (Interview 3, Pos. 10)	But some societies only care about the price of the product and do not think much about the health of the food.	74	6.68
Creating a database of producers and consumers (Interview 3, Pos. 12)	Create a database of producers and consumers.	48	4.33
Determining the amount of need and the amount of demand (Interview 3, Pos. 12)	to determine the amount of need and the amount of demand.	39	3.52
Determining available resources (Interview 3, Pos. 12)	And also show the available resources.	35	3.16
Ease of producing and selling the product (Interview 3, Pos. 12)	This makes it easy to produce and sell the product.	45	4.06

Table 13: Primary (open) coding of the fourth interview text

Code	Segment	Area	Coverage%
Blockchain as a technology	Blockchain is a technological innovation tool.	30	1.10
Spicy food consumption as food security (Interview 4, Pos. 7)	Fast foods are among the food security of every country.	48	1.76

Protecting its data due to the importance of this area	And in terms of the importance of this area, its data is protected.	50	1.83
Full supervision of the beginning and creation of food (Interview 4, Pos. 8)	From the moment you start and create this food, you must have full and sufficient supervision.	74	2.71
Monitoring until supply and distribution and purchase	As long as it is offered and the customer buys.	45	1.65
Not using technology like QR code (Interview 4, Pos. 9)	In my opinion, in terms of classification and giving importance in the field of statistics, we should not use a technology like QR code.	106	3.88
Food control from the moment of production to the finished product (Interview 4)	In order to control food from the moment of production to the finished product, there must be complete supervision.	89	3.25
The impact of blockchain technology (Interview 4, Pos. 11)	Blockchain technology is the only platform that can cryptographically monitor the food production process in the form of classified blocks.	125	4.57
The third generation and to some extent the second generation based on smart contracts	It is the third generation and to some extent the second generation based on smart contracts.	62	2.27
simple blockchain engine and different modules (Interview 4, Pos. 12)	Use a simple blockchain engine and different modules to connect	78	2.85
Conduct route management (Interview 4, Pos. 12)	so that you can complete the route management.	40	1.46
Process monitoring	In this way, this process can be monitored.	52	1.90
Embedding Big Data in this technology (Interview 4, Pos. 13)	Consumable food items such as bread, from the moment of production, which is the planting of wheat seeds in the field, until it becomes flour and bread production, all data must be collected and this big data should be placed in this technology.	184	6.73
Creating a block for every 1 kg of wheat produced (Interview 4, Po)	In other words, for every 1 kg of wheat produced, you must form a block that can be identified	94	3.44
Product identification in all different stages (Interview 4, Pos. 14)	In this chain, this bag of wheat moves and comes to the silo warehouses, where it is transferred to the factory, and finally the bakery turns the flour into bread, and that bread will be determined by which customer bought it. In this way, the product can be identified in all different stages.	259	9.47
Identifying the problem product (Interview 4, Pos. 14)	And if there is a problem in the production process of the product, the product with the problem will be quickly identified and the problem will be solved.	101	3.69
Throwing away the entire product (Interview 4, Pos. 15)	In the event that without the presence of blockchain in the product production process, if a problem occurs, the entire product must be thrown away	106	3.88
Using blockchain and managing each kg of product	But with blockchain, every kg is managed and can be identified and tracked	77	2.82
Throwing away the entire product (Interview 4, Pos. 15)	In the event that without the presence of blockchain in the product production process, if a problem occurs, the entire product must be thrown away	103	3.77
Using blockchain and managing each kilogram of product	But with blockchain, every kg is managed and can be identified and tracked	79	2.89
Determining the transgenic materials added to the product (Interview 4, Pos. 16)	In this way, it is possible to determine when transgenic materials were added to the product and what was the origin of the products.	64	2.34
Product process management and control (Interview 4, Pos. 18)	A tool like QR code cannot necessarily manage and control the product process	120	4.39
The importance of tools and technology (Interview 4, Pos. 18)	Rather, it is a tool and technology that can be used in this direction.	84	3.07
Anti-hacking the route (Interview 4, Pos. 18)	(It anti-hacks the route)	24	0.88
Product management	To be able to manage the product	32	1.17
Not removing blogs from the process	Through blogging different processes and no block can be removed from this process.	80	2.93

Blogging of different processes (Interview 4, Pos. 18)	Through blogging different processes and no block can be removed from this process.	80	2.93
Uncertainty in cyberspace security (Interview 4, Pos. 19)	Of course, security in cyber space is not certain.	37	1.35
Creating transparency (Interview 4, Pos. 21)	Blockchain technology brings transparency.	30	1.10
Creating security (Interview 4, Pos. 21)	It brings security.	14	0.51
Helping business with intelligence with machine learning (Interview 4, Pos.)	It helps your business intelligently with machine learning	57	2.08
Time management in development	Manage time in development	28	1.02
developing in the best possible time	And in the best case, you can do the development.	50	1.83

Table 14: Primary (open) coding of the fifth interview text

Code	Segment	Area	Coverage%
Producer to final consumer levels	We had a similar experience in the field of the highway in the housing bank and in the field of supplying materials and their supply chain for the benefit of various stakeholders at the producer to final consumer levels.	155	2.98
Supply chain for the benefit of different stakeholders	We had a similar experience in the field of the highway in the housing bank and in the field of supplying materials and their supply chain for the benefit of various stakeholders at the producer to final consumer levels.	155	2.98
Reducing transaction costs (Interview 5, Pos. 5)	The main issue that the markets establish is that they minimize the transaction cost.	108	2.07
Cost reduction as the main goal in technology (Interview 5, Pos. 5)	Minimizing costs is the main goal in the technology that you use.	81	1.55
Product development and blockchain with minimum cost (Interview 5, Pos. 5)	For the development of your product and blockchain, it becomes a platform where this happens with minimum cost.	77	1.48
Identify your supplier	Where you can get to know your supplier.	58	1.11
Creating a list of first-tier customers, second-tier customers and final customers (interview)	And in that vendor list of customers of the first row, the second row, so that the final customers, who are the final customers, have at least the story of the cast (payment) and this chain of work can be done.	162	3.11
Minimum Caste (Pay) (Interview 5, Pos. 5)	At least they have the issue of cost (payment) and this chain of work can be done.	76	1.46
Non-ideal sand solution (Interview 5, Pos. 6)	In our collection, two solutions have been designed, one solution is called sand solution. We had an initial experience that was not very popular and was crude and far from ideal.	163	3.13
Creating a marketplace (Interview 5, Pos. 6)	The second experience under the name of marketplace is being implemented and its initial demo has also been uploaded.	76	1.46
Identifying the set of main actors (Interview 5, Pos. 6)	If you assume that the producers, bankers and wholesalers, from production to supply and then to the market and reach the people, you want to identify the main players in this collection.	183	3.51
Identifying the main player (Interview 5, Pos. 6)	Identify the main players.	29	0.56
Clearing the vendor list in the initial section	It means that your vendor list will be completely clear in the initial parts.	53	1.02
Identifying the main players in the master plan and work architecture (Interview 5, Pos.)	So, in the master plan and work architecture, the work engineering should be such that you identify the main players	90	1.73
Recognizing transaction levels (Interview 5, Pos. 6)	The second point is that you must recognize the trading levels.	42	0.81
Making a transaction or transferring credit (Interview 5, Pos. 7)	Sometimes a deal is made. But sometimes it is just a transfer of credit.	80	1.54

Transfer of credit and transfer of goods (Interview 5, Pos. 7)	And this is the credit that is being transferred and leads to the transfer of goods.	72	1.38
Identification of players	The next step is when you know the players	48	0.92
Specifying the roles of the actors in front of each other	Then determine what roles the actors have in front of each other.	52	1.00
Buying and selling goods and transferring credit	There is a time when it is just a B2B and goods are bought and sold, but there is a time when only credit is transferred.	104	2.00
Receiving internal LC from commercial bank (Interview 5, Pos. 8)	For example, I get a domestic LC from a commercial bank and draw it in the name of my beneficiary, which is rice.	82	1.57
Retailing the product (Interview 5, Pos. 8)	As a whole sale, with this internal LC, you will receive your rice and package it for three months. He would see this to Ofogh Koresh and he would give you a check for three months and Ofogh Kourosh would retail the product.	189	3.63
Delivering to people and receiving cash in less than three months	And it will be delivered to the people and the cash will be settled in less than three months	66	1.27
Granting a three-month LC to the customer	You can also give that LC to the first customer for three months; he will buy it in the market and...	81	1.55
Access to information by everyone	The property of blockchain is that everyone has access to information	52	1.00
Observe and control each other	And they see each other and control each other	36	0.69
The lowest cost and with high speed and high quality (Interview 5, Pos. 9)	And the result is that this work is done with the lowest cost and with high speed and high quality.	85	1.63
Developing the model (Interview 5, Pos. 10)	If you can develop your model well.	41	0.79
Recognizing the relationship between model actors (Interview 5, Pos. 10)	And recognize the relationship between the actors of your model well.	55	1.06
parallel design of the financial role (Interview 5, Pos. 10)	Fully design the real design role of your model parallel to the financial role that is on the coin of your model.	90	1.73
The goal of being respectable, developable, and brandable in the country	I think that this model can have a respectable, developable, and brandable goal in the country.	100	1.92
Reduction of transaction costs	For example, the same idea that supermarkets went to market brands such as Ofogh Kourosh and so on. What happened is that they came and reduced the cost of transactions.	149	2.86
Lower cost, higher quality and higher speed (Interview 5, Pos. 11)	If you can make the consumer have an incentive to visit and with 3 factors of lower cost, higher quality, and higher speed	132	2.53
Preparing your product at all levels and creating a successful solution	It can produce its own product at all levels. In my opinion, you have a successful solution.	87	1.67
The need for many system and corporate requirements (Interview 5, Pos. 14)	It is a very difficult question, the answer to which requires a lot of system and corporate requirements.	88	1.69
Product commercialization by identifying the business environment	In order to commercialize a product, you need to know the business environment well.	74	1.42
Knowing the rules	Two, know the rules well	23	0.44
Knowing your competitors	Three, know your competitors well	22	0.42
Penetration in the market (interview 5, Pos. 14)	Fourth, know the influence in the market well	36	0.69
The importance of the role of the Internet in selling goods (Interview 5, Pos. 15)	For example, the role of the Internet in selling goods is very important.	49	0.94
Solution commercialization problems (Interview 5, Pos. 16)	In the simplest and basic form, the problems that exist for commercializing your solution.	60	1.15
System problems (Interview 5, Pos. 16)	There are two problems that I want to say. One is systemic problems	67	1.29
The influence of economic and social factors on the business process	There are a number of issues in macroeconomics, economic and social factors, etc. affect the entire business field	106	2.03
macroeconomic issues	There are a number of issues in macroeconomics, economic and social factors, etc. affect the entire business field	106	2.03
The unpredictability of the economy (Interview 5, Pos. 16)	And the unpredictability of the economy is very important because the stability of the economy affects every business.	106	2.03

Economic instability in transactions	Even if you don't hesitate in your trading room, but in transactions, economic instability can affect the success of your model and cartoon.	136	2.61
Existence of non-systemic factors specific to your company (Interview 5, Pos. 18)	There are a number of non-systemic factors specific to your company	45	0.86
Model monitoring and evaluation	If your model is well monitored and evaluated well	41	0.79
Identifying the position of the actors	The actors who play roles can recognize their position well	55	1.06
Formation of interests of single beneficiaries (Interview 5, Pos. 18)	And the interests form a single beneficiary	42	0.81
Piloting the model (Interview 5, Pos. 18)	And if you can pilot your model and lay the foundation stone well. It will have a good future.	93	1.79
Not knowing about the brand and its specifications	Or they want to buy oil. We had a customer who produced oil that we didn't even know what their brand was.	107	2.05
Providing the product with the lowest price, the highest quality and the shortest time	You should have the goal that, for example, the consumer can get the highest quality meat (product) at the lowest price and in the shortest time.	90	1.73
Identification card of a product (Interview 5, Pos. 26)	If you take out the birth certificate of a product... I don't know what you are looking for.	93	1.79
Product health (Interview 5, Pos. 27)	We are looking for the health of the products	90	1.73
Investing in community health (Interview 5, Pos. 27)	Investing in community health	123	2.36
Surrealist thinking (Interview 5, Pos. 28)	This is surrealistic thinking. This is not the goal of 90% of society. We have to do something so that those who buy rice for 70 tomans will not buy 150 tomans elsewhere. It's not your issue what vaccine you get, your issue is that you should get the vaccine.	68	1.31
Not knowing about the brand and its specifications	Or they want to buy oil. We had a customer who produced oil that we didn't even know what their brand was.	31	0.60
Providing the product with the lowest price, the highest quality and the shortest time	You should have the goal that, for example, the consumer can get the highest quality meat (product) at the lowest price and in the shortest time.	27	0.52
Identification card of a product (Interview 5, Pos. 26)	If you take out the birth certificate of a product... I don't know what you are looking for.	200	3.84

Table 15: Initial (open) coding of the text of the sixth interview

Code	Segment	Area	Coverage%
Determining the authenticity of products requires a reliable laboratory (Interview 6, Pos.)	In order to determine the authenticity of the products, an accredited laboratory is needed, for example, from which fields did a bag of wheat come from, with what water was it irrigated?	189	8.30
Fraud monitoring, management and prevention	For this reason, it should be monitored and managed from where it is produced to prevent counterfeiting.	85	3.73
Tracking and showing the authenticity of the product with reliable laboratories (interview)	This procedure is performed by accredited laboratories. In this way, flour in the value chain is determined from the lowest point until the production of bread, and when it is placed on the table of the people, it can be traced and its authenticity can be shown.	213	9.35
Preventing blockchain from chain fraud (Interview 6, Pos. 7)	What is the role of blockchain in this chain? Blockchain prevents fraud in the chain.	81	3.56
Specifying the blocking of different stages of all product identification	Because by blocking different steps, it specifies all the product's identity card from the beginning to the end. For example, bread that is organic is clear from the beginning with what seed it was made, but wheat that is made from waste water will be completely clear.	216	9.48
Eliminating complications in safe food basket (Interview 6, Pos. 8)	A safe food basket eliminates the complications that exist in the treatment	59	2.59

Alignment of economy and health through safe food basket (Interview 6, Pos.)	And the economy and health will be aligned through a safe food basket.	56	2.46
Reducing the treatment costs (Interview 6, Pos. 8)	Treatment costs will be minimized because the treatment costs are very high.	73	3.20
The cost of creating a blockchain technology food supply chain	Building a blockchain technology food supply chain may be costly at first	79	3.47
The cost during the time of the basket and reducing the cost of treatment (Interview 6, Pos. 9)	This cost will be accumulated over time, the treatment costs will decrease and it will be a kind of investment on health.	105	4.61
The lack of identification of the origin of food materials and products	There is a problem in the consumer's basket now, the origin of many food items and food products is not known.	81	3.56
The existence of security, facilities and pastures in the country (Interview 6, Pos. 11)	This is a problem that must be solved. Our country has very secure facilities and pastures.	74	3.25
Producing a lot of organic and healthy products (Interview 6, Pos. 11)	All these things can cause many organic and healthy products to be produced	69	3.03
Jeopardizing food safety and increasing treatment costs	But today, it is the opposite and people bear a lot of medical expenses due to food safety being compromised.	117	5.14
Ensuring the health of food by health economics (Interview 6, Pos. 12)	For this reason, the health economy must ensure the health of food.	60	2.63
Decreasing the quality of food products and negatively impacting health	When the quality of food gets money, it affects health and environmental pollution is created.	96	4.21
Creating environmental pollution (Interview 6, Pos. 13)	And environmental pollution is created.	32	1.40
Creating authenticity by blockchain technology (Interview 6, Pos. 14)	Blockchain technology wants to create authenticity	46	2.02
Fraud and filth driven by blockchain (Interview 6, Pos. 14)	If all devices are required to use it, it will lead to fraud and filth.	73	3.20
Product authenticity monitor (Interview 6, Pos. 14)	Blockchain technology monitors the authenticity of products.	48	2.11
Giving nature to goods and food (Interview 6, Pos. 15)	It increases the confidence of the buyers of the product and adds character to the goods and food.	78	3.42
Increasing the trust of product buyers (Interview 6, Pos. 15)	It increases the confidence of the buyers of the product and adds character to the goods and food.	78	3.42
Supervision of Jahad Keshavarzi on seed production (Interview 6, Pos. 16)	Institutions that can monitor Jahad Keshavarzi will monitor the production of seeds and code which fields they will be consumed.	118	5.18
Continuous monitoring in factories (Interview 6, Pos. 17)	In the next sections and in the factory, continuous monitoring should be done	64	2.81
Giving nature to goods and food (Interview 6, Pos. 15)	It increases the confidence of the buyers of the product and adds character to the goods and food.	78	3.42
Increasing the trust of product buyers (Interview 6, Pos. 15)	It increases the confidence of the buyers of the product and adds character to the goods and food.	118	5.18
Preventing the penetration of external and internal factors (Interview 6, Pos. 17)	Institutions that can monitor Jahad Keshavarzi will monitor the production of seeds and code which fields they will be consumed.	64	2.81
	And prevent the penetration of external and internal factors, which can be done well in blockchain.	88	3.86

Table 16: Primary (open) coding of the seventh interview text

Code	Segment	Area	Coverage%
The difference in the type of businesses and the move towards virtual business	The further we go, the types of businesses become different and have more similarities with virtual businesses.	87	2.60
Get faster in new markets	Businesses that develop through information technology, in terms of knowing the burden and handling payment terms, everything is going in a direction that can make it reach new markets at a higher speed.	223	6.67

Businesses created through information technology (Interview 7, Pos. 5)	Businesses that develop through information technology, in terms of knowing the burden and handling payment terms, everything is going in a direction that can make it reach new markets at a higher speed.	223	6.67
A solution for monetary and financial transfers (Interview 7, Pos.)	In the blockchain, we are moving in this direction so that it can be a solution for monetary and financial transfers	144	4.31
Helping to develop business	In many countries, it is now due to the sanctions that exist in different countries. Blockchain can be a way forward for some customers and help to develop business.	151	4.52
Sanction challenges (Interview 7, Pos. 5)	In many countries, it is now due to the sanctions that exist in different countries. Blockchain can be a way forward for some customers and help to develop business.	151	4.52
The speed of obtaining information and an approach production (Interview 7, Pos. 6)	The more the mechanisms that are used in the production and the data that you get through information technology, the more it can help you in the speed of obtaining information and producing the approach.	169	5.05
Reducing costs and speed of reaching target markets (Interview 7, Pos. 6)	Or the reduction of costs and the speed of reaching the target markets, even the speed of reaching the primary resources that can be provided.	103	3.08
Using Blockchain and Technology (Interview 7, Pos. 6)	All of these can be put together through blockchain and technology to transform your target from traditional to advanced.	119	3.56
Target conversion from traditional to advanced	All of these can be put together through blockchain and technology to transform your target from traditional to advanced.	59	1.76
Expanding markets and reaching them in a short time	And in this way, you have markets that are vast and you can reach them in less time.	85	2.54
Assigning a huge part of a product production to R&D (Interview 7, Pos. 8)	Maybe it wasn't like this in the past, and we had R&D areas in the past that devoted a huge part of the production of a product to it.	116	3.47
Giving importance to the R&D area	I had a visit to the Development Productivity Organization. From Poloton factory, which spent about 70% of their time in R&D.	127	3.80
Access to data and property supply information (Interview 7, Pos. 10)	What we have reached now, if we have access to the information of data and property supply, markets, customers, and even work strategy, we can speed up all this by using technology and we can even develop it.	80	2.39
Development of markets and customers and work strategy (Interview 7, Pos. 10)	What we have reached now, if we have access to the information of data and property supply, markets, customers, and even work strategy, we can speed up all this by using technology and we can even develop it.	124	3.71
Increasing competition and variety of products	The competition has become much more intense in the market, and your product variety may even increase in the future.	84	2.51
Increasing the standard of goods (Interview 7, Pos. 12)	These are different and can have these advantages. This industry certainly increases the standard of goods.	103	3.08
Tracking products and their manufacturers	With this, you can see where the raw materials of the goods are obtained, and who the producers are; they can have specific supports.	147	4.40
Prevent fake market activity and fraud	And it is much safer and it can stop the activity of the fake market much more, and fraud in this market will decrease.	105	3.14
QR code (Interview 7, Pos. 13)	In any case, you can find out its direction through QR codes and the like.	74	2.21
Increase customer trust	Customers also trust more	32	0.96
Receiving necessary product inquiries (Interview 7, Pos. 13)	They can ask the necessary inquiries about the product and make sure there will be less frauds.	67	2.00
Reduce fraud	They can ask the necessary inquiries about the product and make sure there will be less frauds.	21	0.63
Production outside valid standards (Interview 7, Pos. 14)	In the health sector, there has been no incident that will have bad consequences in the future or anyone who wants to do productions that are out of valid standards in any way.	143	4.28
Providing a suitable model for producers and consumers	It is necessary to have a supervisor to supervise.	122	3.65
Determining integrated supervisory institutions (Interview 7, Pos. 16)	In my opinion, in the end, it can be a model that is good for both the producer and the consumer.	154	4.61

Inspection of the Food and Drug Organization and various organizations (Interview 7, Pos. 17)	Now, due to the fact that the technology is developing rapidly, there is still no clear unified supervisory institutions.	84	2.51
Having producer and consumer interests (Interview 7, Pos. 19)	Now, maybe every country has something for itself. But today, the Food and Drug Organization and various organizations have inspections.	130	3.89
The importance of the existence of a supervisory organization	Basically, it should be a supervisory organization that has all the information of this organization or field and that the interests of producers and consumers are important for it.	132	3.95
Social responsibility supporting production and consumer (Interview 7, Pos. 19)	Social responsibility should be to the extent that it aims to support the producer and consumer.	79	2.36
Decisive attitude and stay away from rent	If something special happens in the framework, it should be dealt with seriously and there should be an organization in charge that is away from rent.	98	2.93
Having high social responsibility	Organizational relations that have a high level of responsibility and social responsibility is the task and goal of its work can be accepted by the whole country.	137	4.10

Table 17: Primary (open) coding of the eighth interview text

Code	Segment	Area	Coverage%
Food safety is one of the important requirements of the food industry (Interview 8, Pos. 6)	One of the important requirements of the food industry is food safety.	51	1.89
Cancer disease caused by unhealthy food chain (Interview 8, Pos. 8)	One of the important requirements of the food industry is food safety. Cancer is common these days, which is caused by the unhealthy food chain.	130	4.81
Starting from the beginning of the supply chain and until its end (Interview 8, Pos. 6)	It starts from the beginning of the supply chain and continues until the end of the supply chain. One of the country's standard requirements and criteria is monitoring the food industry.	137	5.07
Implementing the country's standard requirements and monitoring the food industry	It starts from the beginning of the supply chain and continues until the end of the supply chain. One of the country's standard requirements and criteria is monitoring the food industry.	66	2.44
The importance of supply chain transparency (Interview 8, Pos. 7)	The transparency of the supply chain is very important and has a great impact on the health of the society, and it should be done. Now, for some reasons, this work is not done in the country.	162	6.00
Food having a certificate (Interview 8, Pos. 8)	A food certificate has a great impact on the health of food, but it should be seen which executive body will undertake this task.	62	2.30
executive body (Interview 8, Pos. 8)	A food certificate has a great impact on the health of food; it should be seen which executive body will undertake this task.	59	2.19
Delay in implementation (Interview 8, Pos. 8)	What are the factors that delay the implementation of this issue?	62	2.30
Work coordination of different organizations (Interview 8, Pos. 8)	One of them is the parallel work of different organizations.	42	1.56
The cooperation of some organizations until the implementation of the process	Which organizations should cooperate with each other to implement this process. Food and Drug Organization and... until the task is determined.	67	2.48
Determining the task of the Food and Drug Organization (Interview 8, Pos. 8)	Which organizations should cooperate with each other to implement this process. Food and Drug Organization and... until the task is determined.	43	1.59
Accepting work responsibility (Interview 8, Pos. 8)	This case will be delayed until a governing organization takes responsibility for the work.	84	3.11
Compliance with criteria and standards to increase quality (Interview 8, Pos. 9)	Definitely, for every product, criteria and standards must be followed so that the quality is high.	89	3.30

Compliance with global standards in distribution (Interview 8, Pos. 9)	Unfortunately, we do not comply with many international standards in distribution and even packaging.	83	3.07
Having standards for each step-in picking, transporting and packing methods	For example, from the type of seed in agricultural products to the fertilizer they give, the method of picking, transporting and packing it, which has a wide range and must have the necessary standards at every stage.	171	6.33
Food and drug standards and their distribution and conditions (Interview 8, Pos. 9)	Does its distribution and conditions meet food and drug standards? How is it even consumed? Does it have drug interactions? Is it forbidden to use or not?	128	4.74
Non-implementation of the plan	Whether this issue will be implemented and until a governing and authoritative organization does not investigate and issue approval, there will be problems in the whole work and will cause the plan to be unimplemented.	149	5.52
The governing organization and authority and the examination and issuance of approval (Interview 8, Pos. 9)	And whether this issue will be implemented and until a governing and authoritative organization does not investigate and issue approval, there will be problems in the whole work and will cause the plan to be unimplemented.	149	5.52
Management Evidence (Interview 8, Pos. 10)	According to my experience and the management evidence that exists, this procedure will lead to management failure. This is an arbitrary management procedure that causes problems in production and entrepreneurship. The existence of this requirement is for transparency.	57	2.11
Creating problems in production and entrepreneurship (Interview 8, Pos. 10)	According to my experience and the management evidence that exists, this procedure will lead to management failure. This is an arbitrary management procedure that causes difficulties in production and entrepreneurship. The existence of this requirement is for transparency.	156	5.78
The importance of transparency (Interview 8, Pos. 10)	According to my experience and the management evidence that exists, this procedure will lead to management failure. This is an arbitrary management procedure that causes difficulties in production and entrepreneurship. The existence of this requirement is for transparency.	27	1.00
There is a problem in the implementation of this plan due to the prevailing conditions in the country	For example, when the world sends back our food and agricultural products, the problem must be solved with clarification; the implementation of this plan should be done according to the conditions prevailing in the country.	156	5.78
Administrative bureaucracy and creating problems for the entrepreneur (Interview 8, Pos. 10)	It will become an administrative bureaucracy that only causes problems for entrepreneurs and producers.	92	3.41
Blockchain's impact on criteria and standards (Interview 8, Pos. 1)	Blockchain technology affects the criteria and standards.	55	2.04
Maintaining the required product quality at all levels of production (interview 8, Pos. 11)	Because at all levels of product production, it must produce the required quality.	59	2.19
Obtaining necessary information about the product (Interview 8, Pos. 13)	On the other hand, the food supply chain using blockchain technology affects the efficient distribution of products. The consumer can get all the necessary information about the product.	167	6.19
influencing the efficient distribution of products (Interview 8, Pos. 12)	On the other hand, the food supply chain using blockchain technology affects the efficient distribution of products.	98	3.63
Preventing food and drug interference (Interview 8, Pos. 13)	In this way, food and drug interactions are avoided.	49	1.81
Identification of food supplements (Interview 8, Pos. 13)	Food supplements will be identified and the food chain will be managed in this way.	26	0.96
Feed chain management (Interview 8, Pos. 13)	Food supplements will be identified and the food chain will be managed in this way.	43	1.59
The importance of management in the chain (Interview 8, Pos. 14)	The most important factor in this chain is its management. Management should be mandatory.	61	2.26
Iranian Nutrition Association, Food and Drug Organization as the trustee organization	The trustee organization can be the Iranian Nutrition Association, Food and Drug Organization.	68	2.52

Table 18: Primary (open) coding of the ninth interview text

Code	Segment	Area	Coverage%
The impact of blockchain on all aspects of the supply chain (interview 9, Po)	Blockchain is a new technology that affects all aspects of the supply chain, from supply of inputs to other matters.	100	3.66
Creating competition in the entire chain	Because we see competitiveness in the entire chain. We have to start from the farm until after processing and consumption. Based on this, blockchain can have an impact from providing inputs for farms to the input of the factory.	96	3.52
The effectiveness of blockchain from the beginning to the end of product production	Because we see competitiveness in the entire chain. We have to start from the farm until after processing and consumption. Based on this, blockchain can have an impact from providing inputs for farms to the input of the factory.	94	3.44
Developing technology levels	Technologies are more advanced.	38	1.39
Development on traditional processes and its improvement	And some processes are still traditional and we have to do development work on them to reach a level where the technology can be used.	120	4.39
The level of chain balance as a problem (Interview 9, Pos. 9)	The balance level of the chain is one of the problems of the entire chain. Because in different circles, the level of technology and knowledge of the custodians or the main activities are different.	49	1.79
Different level of technology and knowledge of the trustees (Interview 9, Pos. 9)	The balance level of the chain is one of the problems of the entire chain. Because in different circles, the level of technology and knowledge of the custodians or the main activities are different.	74	2.71
The existence of different types of activities at different levels of technology	Some activities are with technology and some are indebted to technology. For some rings, the technology is at a higher level.	102	3.73
Need for physical and soft infrastructure (Interview 9, Pos. 10)	In the case of blockchain, we need a physical infrastructure and a soft infrastructure is needed.	77	2.82
Pathology in the whole chain (Interview 9, Pos. 10)	It is important to conduct pathology in the whole supply chain.	58	2.12
Technology situational assessment and technology application in the field of hardware and software	What is the current state of technology and the application of technology in the field of hardware and software, and according to that, the necessary development should be seen.	116	4.25
Preparing a general development plan	Part of this process requires preparation. Some infrastructures must be provided so that you can prepare a general development plan for it.	110	4.03
The need for legislation (Interview 9, Pos. 13)	There is a need for legislation that includes the blockchain platform in those laws.	78	2.86
The ruler and trustee of the high levels of the Ministry of Home Affairs, Jihad Keshavarzi and the Ministries of Industry	And it needs a high-level authority and trustee, such as the Ministry of Home Affairs, Jihad Keshavarzi, and the Ministries of Industry or Telecommunications.	94	3.44
Preparation of infrastructure	that can prepare the infrastructure for your work.	34	1.24
Inconsistency in the level of the stakeholders' common language (Interview 9, Pos. 13)	It is a fundamental problem that when we want to talk about these technologies, the level of communication is not the same in terms of its beneficiaries.	116	4.25
Creating governance rules and road map (Interview 9, Pos. 13)	Second, in the whole of this supply chain, there are no governance rules and no road map to do it.	87	3.19
Lack of unit trustee (Interview 9, Pos. 13)	The next issue is that there is no single trustee for these works.	60	2.20
Rani's ruling and integrity of governance (Interview 9, Pos. 13)	There are many groups and stakeholders in which there is no governance and integrity of governance, these are the obstacles that should be removed and the rules should be written accordingly.	148	5.42
Multiple categories and stakeholders (Interview 9, Pos. 13)	There are many groups and stakeholders in which there is no governance and integrity of governance, these are the obstacles that should be removed and the rules should be written accordingly.	148	5.42
Finance supply chain and focus on financing (Interview 9, Pos. 14)	Sakkook system of Tosun company is a good example of finance supply chain. and focuses on financing.	89	3.26
Importing raw materials, processing them and reaching the consumer	For example, in the production of liquid oil for household consumption, a series of raw materials are imported by traders and importers, and then they are processed in sites and distributed somewhere and reach the consumer.	193	7.07
Action on different financing points (Interview 9, Pos. 16)	In this chain, it is financed from different points.	62	2.27
Failure to increase financing efficiency (Interview 9, Pos. 16)	It makes the efficiency of financing not high, but in supply chain financing, you target the beginning and the end of the financial chain.	120	4.39
Financing of suppliers of input materials (Interview 9, Pos. 16)	Once we finance the supplier of the input materials.	53	1.94
A method of new financing (Interview 9, Pos. 17)	On this platform, they launched the Sakkok system. The central bank also communicated this issue to other banks as a method of new financing. These are well researched and almost obvious problems.	144	5.27
Identifying problems by conducting research	On this platform, they launched the Sakkok system. The central bank also communicated this issue to other banks as a method of new financing. They have done good research and the problems are almost obvious.	56	2.05

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