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# FORECAST INDICATORS OF IMPLEMENTATION OF ISO 22000 FOOD SAFETY MANAGEMENT SYSTEM IN UZBEKISTAN

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**Abstract**
In this article, based on the least square equation, a model is developed to predict the degree of completeness of the food safety management system based on the ISO 22000 standard in Uzbekistan and the scale of certification indicators of management systems in the future.

**Keywords:** certificate, mathematical modeling, direct regression, probabilistic assessment.

## INTRODUCTION

Currently, food is produced, processed and consumed in different parts of the world. The impact of growing international trade on food losses needs to be properly assessed. In addition, due to the globalization of trade and international food trade, each participant must comply with international management system standards. Currently, food is produced, processed and consumed in different parts of the world. The impact of growing international trade on food losses needs to be properly assessed. In addition, due to the globalization of trade and international food trade, each participant must comply with international management system standards.

In the world, there is a comprehensive organization of the activities of food production centers, the creation of a system for assessing the quality and safety of food products at the request of the public, while research work is being carried out aimed at the food risk management system and its problems. and decisions are being made [1]. This section includes supply and demand related to food production, agricultural processing, packaging, food additives used to improve the quality of food products, as well as the development of a variety of equipment and consumables for the food industry. special attention is paid to developing the most optimal solution, based on the possibility and circumstances of applying the ISO 22000 certificate for food safety management, to ensure the quality and safety of products, as well as closing the way to reduce negative factors affecting the quality and safety of products.

Stable provision of quality food products to the population of Uzbekistan, support for agricultural producers, production of competitive and export products,

harmonization of national standards with the requirements of international standards, assessment of product quality and safety at the level of international standards, certification, production and service. Targeted and consistent measures are being implemented to implement international quality management systems in the display system and its certification, and certain results are being achieved. The introduction of management systems at enterprises in accordance with the requirements of international standards is a guarantee of competitiveness and provides consumers with high-quality and environmentally friendly products. This creates the basis for capturing foreign markets. The issue of increasing export opportunities and expanding the geography of the market is outlined in the "Development Strategy of the New Uzbekistan for 2022-2026", including "... in order to export products to foreign countries without obstacles and problems, international certificates and standards (Global G.A.P, Organic, HACCP, etc.) necessary tasks for widespread implementation... In the implementation of these tasks, it becomes important to implement international standards ISO 22000, based on the principles of hazard analysis and critical control points ("HACCP" - Hazards Analysis and Critical Control Points) at enterprises , participating in the production system of the food industry [3].

It should be noted that the main purpose of the ISO 22000 certificate is to harmonize food safety management procedures among food chain organizations globally, as this food safety management system standard works in conjunction with other popular international management system standards such as ISO 9001. Additionally, ISO 22000 certification provides confidence in the global supply chain, allows products to cross borders and increases customer confidence [2].

It has been studied by many foreign and domestic scientists on scientific, methodological and practical issues of quality management, formation, implementation and implementation of food safety management systems at food industry enterprises. In particular, A.B. Lisitsyn, I.M. Chernukha, Paulo Sampaio, Y.Taylor, N.I. Dunchenko, L.P. Bessonova and scientists of our country G.E.Shaikhova, H.T.Salomov, S.A.Abdurakhimov, P.R.Ismatullaev, A.A.Artikov, I.R.Askarov, G.H.Khamrakulov, N.Sh.Muminov, G.I.Shaikhova, Sh.A.Turaev, A.Sh.Azizov and others. In their works and research, general aspects, requirements and issues of quality management, implementation of food safety management systems are considered. Product quality management and factors influencing product quality were studied [3].

As a result of these studies, quality management systems are used by the management of manufacturing enterprises with positive results to a certain extent, but based on the

principles of "HACCP" in the food production process, indicators of the implementation of ISO 22000 standards in the future, the formation of future results, the development of forecasting parameters using mathematical models, specific exit issues are poorly understood.

Currently, food is produced, processed and consumed in different parts of the world. It is recommended to implement the ISO 22000 food safety management system standard to ensure the quality and safety of food and export products. The purpose of this research work is to study the level of implementation of the ISO 22000 food safety management system in Uzbekistan and develop forecast parameters for the period until 2030.

## MATERIALS AND METHODS

Based on the above considerations, statistical data for 2011–2022 were studied on the implementation of ISO 22000 standards and the number of certificates at food industry enterprises of the Republic of Uzbekistan. Also in this direction, we sought to develop parameters for predicting future results using mathematical models.

The study used scientific observation, statistical observation, statistical graphs, comparative analysis, data grouping, and methods of abstract logical thinking. These research methods will make it possible to predict how in the coming years the number of enterprises and organizations that comply with the ISO 22000 standard will increase in our country.

Currently, food is produced, processed and consumed in different parts of the world. The impact of growing international trade on food losses needs to be properly assessed. In addition, due to the globalization of trade and international food trade, each participant must comply with international management system standards [2].

Accordingly, over the past decade, the number of ISO 22000 certificates in our country's food industry has increased (Figure 1), which reflects not only the required quality of food products, but also the desire of these enterprises to improve their image in the domestic market. market. Also, the ISO 22000 certificate is a potential marketing tool for entering foreign markets, since it is a common language with stakeholders [4].

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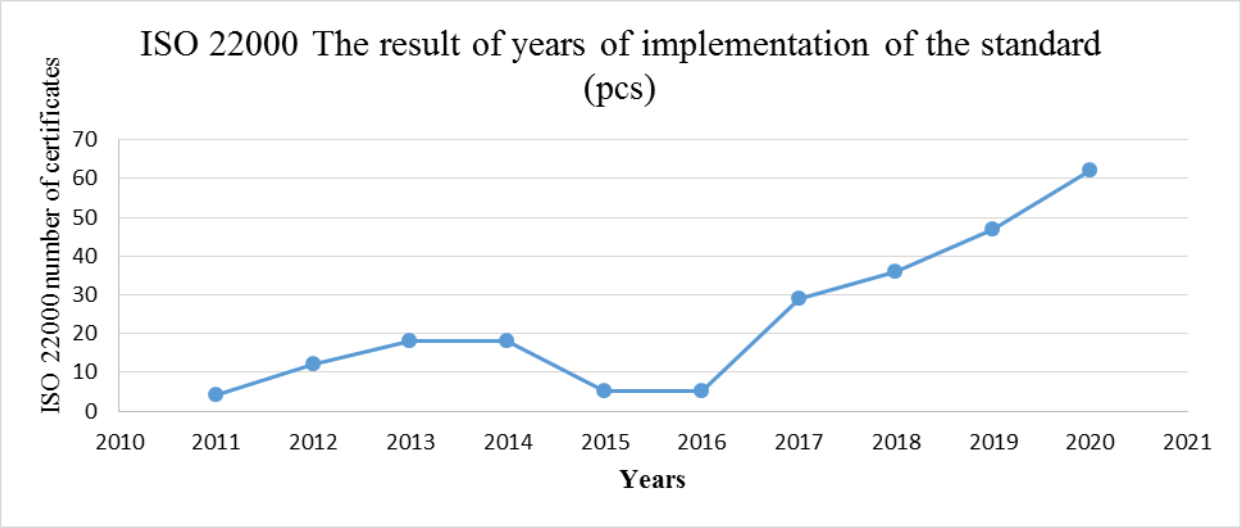


**Figure 1. Dynamics of ISO 22000 certificates in Uzbekistan**

Using statistical data for 2011-2022 (Table 1), we examined the forecast of the number of enterprises implementing the ISO 22000 food safety management system standard for the period from 2022 to 2030 using the least squares method [4].
This research work calculates the number of ISO 22000 certificates obtained in our country from 2011 to 2022.

**Data used to build the forecasting model**

Table 1

| Year | Counter (Xi) | Number of ISO 22000 certificates issued (Yi) |
|---|---|---|
| 2011 | 1 | 4 |
| 2012 | 2 | 12 |
| 2013 | 3 | 18 |
| 2014 | 4 | 18 |
| 2015 | 5 | 5 |
| 2016 | 6 | 5 |
| 2017 | 7 | 29 |
| 2018 | 8 | 36 |
| 2019 | 9 | 47 |
| 2020 | 10 | 62 |
| 2021 | 11 | 52 |

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When assessing the current situation, the information in table is the basis for assessing the situation with the formation of numbers for the coming years for the ISO 22000 certificate.

We use the following mathematical equation (1.1) to make predictions using a nonlinear parabolic regression equation using the least squares method.

$$Y = a * x^2 + b * x + c \qquad (1.1);$$

In this functional relationship, a, b, c are unknown parameters, and to determine the unknown parameters we use one of the mathematical methods - the least squares method. The least squares method expresses the following condition:

$$f(x) = [\sum_{i=1}^{n} y_t - a * x_t^2 - b * x_t - c] - min \qquad (1.2);$$

The least squares method requires that the squared differences between a function and its model $(a * x^2 + b * x + c)$ have the smallest value. The condition that the degree of an expression is equal to two means that the sum of the absolute values of the sections, that is, the square of the resulting sum, must reach the smallest value. This means that the function and model values should be approximately close to each other. Consequently, the model process represented by equation (1.1) is correctly reflected. To find the unknown parameters, special derivatives with respect to the unknowns a, b, c are taken from formula (2.2) and set equal to "0":

$$\begin{cases} f_a(x) = \frac{df}{da} = 0 \ \text{т.е} \ \frac{df}{da} = 2\sum_{t=1}^{n}[y_1 - ax_1^2 - bx_1 - c] * [-x_1^2] = 0 \\ f_b(x) = \frac{df}{db} = 0 \qquad \frac{df}{db} = 2\sum_{t=1}^{n}[y_1 - ax_1^2 - bx_1 - c] * [-x_1] = 0 \\ f_c(x) = \frac{df}{dc} = 0 \qquad \frac{df}{da} = 2\sum_{t=1}^{n}[y_1 - ax_1^2 - bx_1 - c] * [-1] = 0\,. \end{cases} \qquad (1.3)$$

Using action (1.3), the following system of equations (1.4) is created:

$$\begin{cases} \sum_{i=1}^{n} y_i x_i^2 = a\sum_{i=1}^{n} x_i^4 + b\sum_{i=1}^{n} x_i^3 + c\sum_{i=1}^{n} x_i^2 \\ \sum_{i=1}^{n} y_i x_i = a\sum_{i=1}^{n} x_i^3 + b\sum_{i=1}^{n} x_i^2 + c\sum_{i=1}^{n} x_i \\ \sum_{i=1}^{n} y_i = a\sum_{i=1}^{n} x_i^2 + b\sum_{i=1}^{n} x_i + \sum_{i=1}^{n} c \end{cases} \qquad (1.4)$$

where: n- is the sample size, $Xi$ is the observation at the i-step, $Yi$ - is the value of the observation at the i-step [3].

Using the information in Table 1, we can complete Table 2. Find the unknown quantities a, b, c in this system of equations using the information in Table 2 below:

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**($\overleftrightarrow{Yi} - Yi$) - table for finding the average value of observations**

table 2

| Years | X | Results | $X_i * Y_i$ | $X_i^2 * Y_i$ | $X_i^2$ | $X_i^3$ | $X_i^4$ | $(Y_i - \overleftrightarrow{Y}_i)^2$ | $(Y_i - \bar{Y})^2$ | $\bar{Y}$ |
|---|---|---|---|---|---|---|---|---|---|---|
| 2011 | 1 | 4 | 4 | 4 | 1 | 1 | 1 | 24.24 | 492.03 | |
| 2012 | 2 | 12 | 24 | 48 | 4 | 8 | 16 | 11.51 | 144 | |
| 2013 | 3 | 18 | 54 | 162 | 9 | 27 | 81 | 71.49 | 324 | |
| 2014 | 4 | 18 | 72 | 288 | 16 | 64 | 256 | 39.18 | 324 | |
| 2015 | 5 | 5 | 25 | 125 | 25 | 125 | 625 | 103.86 | 25 | |
| 2016 | 6 | 5 | 30 | 180 | 36 | 216 | 1296 | 222.00 | 25 | |
| 2017 | 7 | 29 | 203 | 1421 | 49 | 343 | 2401 | 9.83 | 841 | **26.18** |
| 2018 | 8 | 36 | 288 | 2304 | 64 | 512 | 4096 | 8.49 | 1296 | |
| 2019 | 9 | 47 | 423 | 3807 | 81 | 729 | 6561 | 29.56 | 2209 | |
| 2020 | 10 | 62 | 620 | 6200 | 100 | 1000 | 10000 | 114.57 | 3844 | |
| 2021 | 11 | 52 | 572 | 6292 | 121 | 1331 | 14641 | 105.8 | 2704 | |
| **Total** | **66** | **288** | **2315** | **20831** | **506** | **4356** | **39974** | **740.58** | **12228.03** | |

We will find the unknown coefficients by solving the following system of equations (1.5):

$$\begin{cases} 20831 = a * 39974 + b * 4356 + c * 506 \\ 2315 = a * 4356 + b * 506 + c * 66 \\ 288 = a * 506 + b * 66 + c * 11 \end{cases} \quad (1.5)$$

where: a=10.4974; b= -2.202; c=0.628, and the reliability coefficient is calculated using formula (1.6) [3].

$$R^2 = 1 - \frac{\sum_{i=1}^{n}(Y_i - \overleftrightarrow{Y_i})^2}{\sum_{i=1}^{n}(Y_i - \bar{Y})^2} \quad (1.6)$$

where: $Yi$ — is the observation value at the i-th step, $\overleftrightarrow{Y}i$ — is the value of equation (1) at the $i$-th step, $\bar{Y}$ is the average value of Y-observations.

The found values are reduced to the nonlinear parabolic regression equation (1) and an equation of the form (1.7) is created. The value x=12 is entered into the nonlinear parabolic regression equation and the number Y= 74.53 is calculated.

$$\overleftrightarrow{Y}i = ax_i^2 + bx_i + c \quad (1.7)$$

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We determine the probability of this forecast being realized using formula (1.6). To do this, we will need the data from Table 2 and fill it out.

$$R^2 = 1 - \frac{740,58}{12228,03} = 0,9394$$

If we convert the found value into percentages, then the implementation rate of the ISO 22000 standard in 2022 is 74, which means that the prediction (forecast) was carried out with an accuracy of 94%.

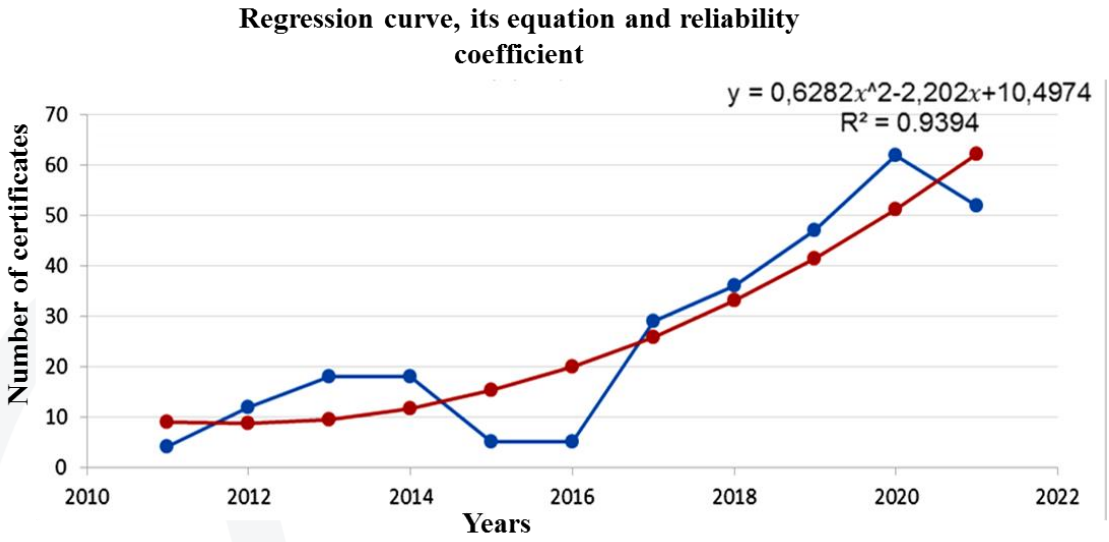


**Figure 2. Regression line, its equation and reliability coefficient on the number of enterprises that implemented the ISO 22000 standard in 2010-2022.**

Using this $\overleftrightarrow{Y}i = ax_i^2 + bx_i + c$ equation (2.7), we can calculate the cost forecast for the next nine-year period.

## RESULTS AND DISCUSSION

Our country is carrying out large-scale reforms to ensure and strengthen food security. In recent years, the state of Uzbekistan has achieved significant results in this area. This can also be learned from the Global Food Security Index data at the international level.

It is known that the ranking of countries according to the Global Food Security Index is published by the Esonomist Imrast magazine. At the end of 2021, the level of economic acceptability (availability) of food products in Uzbekistan was 49.3%, the level of accessibility and sufficiency - 51.3%, the level of quality and safety - 65.1%, the average - 53.8%. . In the 2012 assessment, these figures were 35.1%, 44.9%, 42.5% and

40.8%, respectively. It can be seen that over the past 10 years there has been an increase of 13% [5]. (See Figure 3)

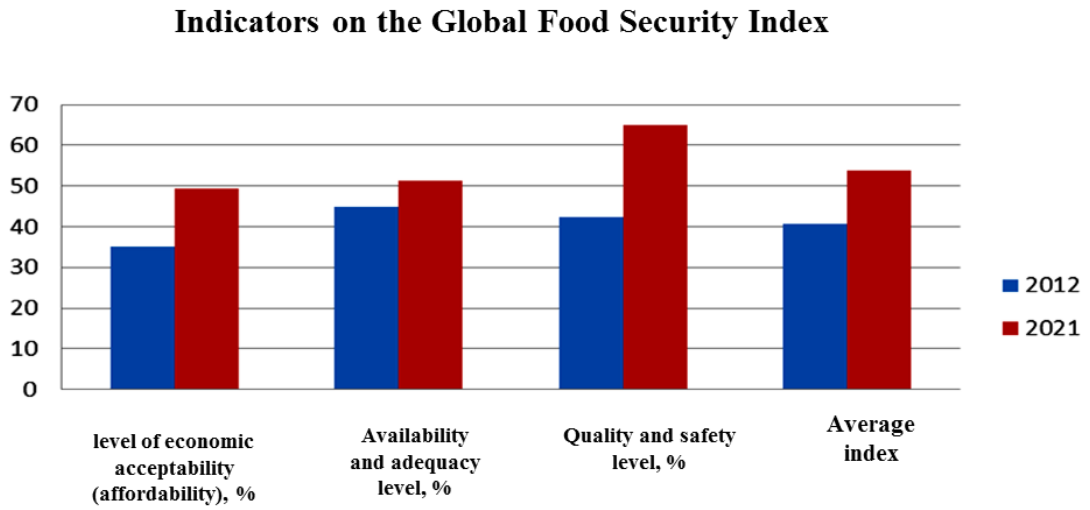


**Figure 3. Uzbekistan's performance on the global food security index**

Based on the results of the study using the least squares method, forecasting parameters were developed for the period until 2030 for the number of certificates reflecting the implementation of the ISO 22000 standard (Table 3).

**Table of forecasts for the coming years** Table 3

| Years | X | Result of implementing the ISO 22000 standard over the years (pieces) | $\overleftrightarrow{Y}_i$ |
|---|---|---|---|
| 2011 | 1 | 4 | 8,92 |
| 2012 | 2 | 12 | 8,61 |
| 2013 | 3 | 18 | 9,54 |
| 2014 | 4 | 18 | 11,74 |
| 2015 | 5 | 5 | 15,19 |
| 2016 | 6 | 5 | 19,90 |
| 2017 | 7 | 29 | 25,86 |
| 2018 | 8 | 36 | 33,09 |
| 2019 | 9 | 47 | 41,56 |
| 2020 | 10 | 62 | 51,30 |
| 2021 | 11 | 52 | 62,29 |
| 2022 | 12 | | 74,53 |
| 2023 | 13 | | 88,04 |
| 2024 | 14 | | 102,79 |
| 2025 | 15 | | 118,81 |
| 2026 | 16 | | 136,08 |
| 2027 | 17 | | 154,61 |
| 2028 | 18 | | 174,39 |
| 2029 | 19 | | 195,44 |
| 2030 | 20 | | 217,73 |

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Based on the initial data and values, the following graph was constructed using mathematical modeling using the least squares method (Figure 4).

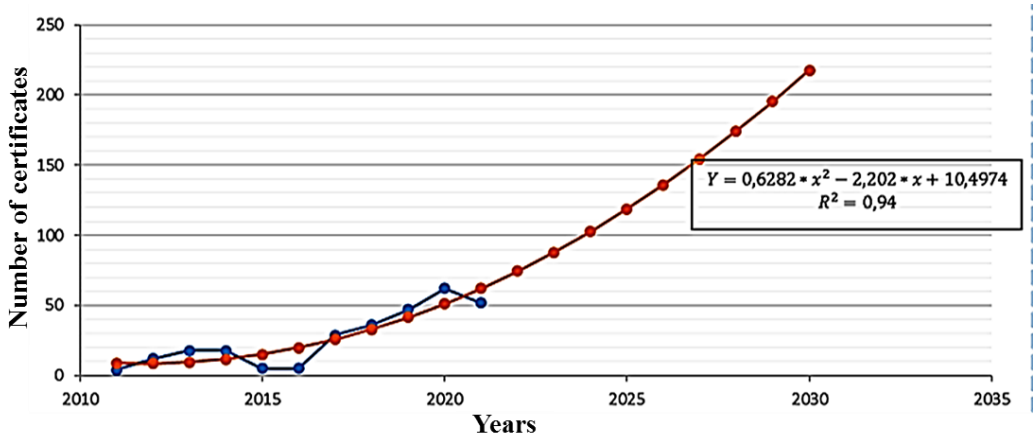


**Figure 4. Forecast graph of ISO 22000 certification indicators for the coming years**

Therefore, based on the above analysis, it is predicted that by 2030, the number of enterprises that have received ISO 22000 food safety management system certification will be 218, or the formation of a curvilinear growth trend, and the reliability level of this situation will be 94%.

As a result of the study, the results obtained based on statistical data were calculated using the least squares method and it was predicted what the indicator would be in the coming years. Of course, the reliability rate of the results is 94%, which is more reliable than the linear regression method of this method.

## CONCLUSION

As a result of the study, the following conclusion can be drawn: taking into account the forecasting model based on the available data for the ISO 22000 certificate, it is predicted that in 2030 218 certificates will be issued, and the reliability coefficient will be 94%. Using this forecast, it is possible to determine the level of implementation of the quality and safety management system at enterprises and what work should be done on certification in terms of food safety.

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