Research Article

Grid Supervision Path of Platform Food Safety Collaborative Governance Based on Big Data

Xin Zhang¹ and Weiguo Tian²

¹College of Business, Jiaxing University, Jiaxing 314001, Zhejiang, China
²Zhejiang Wanli University, Ningbo 315100, Zhejiang, China

Correspondence should be addressed to Xin Zhang; zcxin9@163.com

Received 7 July 2022; Revised 9 August 2022; Accepted 17 August 2022; Published 6 September 2022

1. Introduction

Food safety is an important indicator to ensure the health and happiness of people’s lives. However, the current domestic food safety situation is not optimistic. Food poisoning and food hygiene problems often occur. Hence, it is necessary to pay great attention to it and supervise the issue. At this stage, the country has entered a new historical stage of building a well-off society, and the living standards of residents have continued to improve. However, in recent years, there have been continuous outbreaks of food safety incidents across the country, including the Sudan Red incident, the melamine incident, and the Fuyang low-quality milk powder incident. People have directed their attention to food safety to a new position and have also put forward new requirements for the construction of the domestic food legal system and the construction of a regulatory model. Domestic government departments emphasize the division of the responsibilities of each department based on the degree of specialization. The resulting organizational boundary barriers, overlapping functions, and departmental protectionism have caused problems, such as local protectionism, segmented management, and fragmentation of service chains in domestic government governance, and it is getting worse.

The rapid development of network technology and the concept of “Internet +” have provided new ideas for domestic food safety monitoring. The characteristics and advantages of Internet big data are an important way to solve the current domestic food safety monitoring problems. The unification of network technology and food safety supervision will definitely become the development trend of food safety supervision in the future. Although the country attaches great importance to food safety issues and laws and systems have been continuously improved, it is still far from achieving the expected results, and the shortcomings of traditional food safety supervision are becoming more obvious. To make up for this shortcoming, this article attempts to establish a food risk coefficient evaluation system. The food risk coefficient evaluation system analyzes and discusses the...
significance of food safety, the types of food risk factors, and the degree of influence on food safety from the perspective of evaluation objects and supervision. It provides the basis for the construction of food risk coefficients. Combined with the collection of big data, the food safety grid-based surveillance has been implemented, and the food safety management system has been continuously improved.

In recent years, the explosive growth of big data has attracted widespread attention in designing efficient indexing and search methods. In many key applications, such as large-scale search and pattern matching, finding the nearest neighbor of a query is a basic research problem. The approximate nearest neighbor (ANN) search based on the hashing technology has become popular because of its good performance in efficiency and accuracy. Wang combines the data-driven learning method into a new method in the development of advanced hash functions [1]. The method based on big data is developing very rapidly in today's society, however, combined with advanced hash function, this article mainly discusses the grid management of food safety. Nowadays, the advancement of information technology has witnessed the tremendous advancement of healthcare technology in various fields. However, these new technologies have also made healthcare data not only larger but also more difficult to process. To provide more convenient healthcare services and environment, Zhang proposed a cyber-physical system based on cloud and big data analysis technology for patient-centric healthcare applications and services, called Health-CPS [2]. This technology is mainly used for medical services. Although it is based on the background of big data, it has little reference in food safety management. Big data flow mobile computing is proposed as a paradigm that relies on the integration of broadband Internet mobile networks and real-time mobile cloud computing. It aims to promote the rise of new self-configuring integrated computing communication platforms to offload and process big data streams acquired by mobile/wireless devices with limited resources in real time. Baccarelli elaborated on this paradigm, discussed its most important application opportunities, and outlined the main challenges of real-time energy-saving management of distributed resources available to mobile devices and internet-connected data centers [3]. He has done deep research on big data, however, it is of little use in food safety management. The food industry is the fourth largest industrial sector in Germany, and the desire for innovation is classified as low. Compared with the chemical industry, the food industry faces greater challenges because of the higher and more complex processing requirements for raw materials. Zettel introduced the characteristics of food manufacturing and demonstrated the potential of optical process analyzers based on NIR, fluorescence, Raman spectroscopy, and digital image analysis [4]. He mainly studied the characteristics of food manufacturing; however, it had nothing to do with the grid management of its safety. Some people also study the aspects of food safety managers. The purpose of Lee HY’s research is to develop materials for food safety and nutrition management education programs. The program is aimed at single elderly people. FGI determines the needs of single elderly people for food safety and nutrition management education and planning materials [5]. He aims to study the food safety of single elderly people, however, this article mainly explores the grid-based management of food safety in the context of big data. An effective traceability system is very important for food safety and public health. Dzwolak introduced the research results of the internal traceability of the implementation of the Food Safety Management System (FSMS) for six small Polish food companies from 2013 to 2014. He proposed two key performance indicators related to the available traceability record (ATR) and traceability time (TT), which are very valuable for the continuous improvement of traceability within small food companies [6]. His research is mainly on the enterprise food safety management system, however, there are some differences in the national grid management. Anvari-Moghaddam A introduced an effective energy management system (EMS) suitable for integrated building and microgrid systems and implemented it as a multiobjective optimization problem. The proposed architecture covers different key modeling aspects, such as the distributed heat and power generation characteristics, heat transfer, and thermodynamics of sustainable residential buildings and load scheduling potential of household appliances with related constraints. Through various simulation studies using real data, different system constraints and user goals in different working scenarios, compared with existing residential EMSs, the validity and applicability of the proposed model are studied and verified [7]. Yi considers the energy dispatching of the grid-connected microgrid in a park in Shanghai under a distributed framework to improve its economy and environmental friendliness. The microgrid consists of distributed power generation (DG), energy storage systems, and transferable loads. He proposed a new distributed model predictive control (MPC) for power dispatch optimization of microgrids, where each entity has a local MPC: DG, storage battery, and movable load [8]. His application of grid management to the issue of microgrid energy dispatch is not unrelated to the management of food safety, the main theme of this article.

The innovation of this article lies in the construction of a comprehensive food safety grid management platform project based on the overall planning and unified management of the city’s food safety resources, based on the background of big data, and finally achieving the goal of one grid and one dedicated person. The hierarchical and hierarchical thinking of the grid management method divides the complex and huge whole into unit grids, so that the management objects in the unit grids are simple, clear, and easy to manage, and the close connections between the grids are established through a vertical organization. Its main advantage is that it can greatly improve the utilization of software and hardware resources, avoid repeated construction, and have good social and economic benefits.
2. Food Safety Grid Management Method Based on the Background of Big Data

2.1. Food, Food Safety, and Food Safety Supervision

2.1.1. Food. Food [9] is a necessity to maintain human existence and the material basis for human beings to engage in social activities. In terms of connotation, food is different from food. Food includes the basic characteristics of the material’s external attributes, such as color, fragrance, and taste, and it can meet the needs of human survival. It emphasizes that it can be eaten by humans for the necessities of human life. Its composition is shown in Figure 1. Food is an item that can be eaten or drunk by humans. It emphasizes the commodity attributes of food, and because food is ultimately traded as a commodity, it also reflects social attributes. Regarding the definition of food, different countries and different international organizations have their own different interpretations. China revised the Food Safety Law in 2015 and defined the concept of food. “Food refers to all kinds of finished products and raw materials for human consumption or drinking, as well as articles that are traditionally both food and Chinese medicinal materials, but do not include articles for the purpose of treatment.”

The Food Safety Law [10] defines food as follows: food refers to any article and initial material that is given to people for tasting or drinking, and at the same time, it includes articles that can be used as food and medicine according to the traditional definition, however, things that are premised on treatment need to be deleted. In the “Modern Chinese Dictionary,” food is defined as follows: “food refers to food that is manufactured in a specific way based on specific edible ingredients and sold in stores.” The International Food Standards Committee also defines food as follows: “it is processed, semiprocessed, and unprocessed substance that is consumed by humans, including foods used in the manufacture or preparation of beverages, chewing gum, and processed foods. However, it does not include substances used only as cosmetics, cigarettes, and medicines.” In Basic Terms of the Food Industry, food is defined as follows: “in addition to cigarette leaves and the above-mentioned substances, finished products, semifinished products, unprocessed foods, and other substances that can satisfy people’s dietary choices are called foods.”

2.1.2. Basic Concepts of Food Safety. The issue of food safety [11] runs through the entirety of human development and is the guarantee of a country’s social stability, order, and economic development. Therefore, food safety issues have attracted much attention. Every country, whether developed or developing, has raised this issue to a fairly high strategic level. It is a relatively dynamic and constantly changing concept. With the development of history and social progress, people’s understanding of food safety has gradually changed, and the meaning of food safety has been continuously revised and expanded. Different periods and organizations have defined the concept of food safety from different perspectives.

Since 1980, international organizations related to food safety in some countries have begun to use overall supervision, overall legislation, and the formulation of unified standards as means to replace the previous regulatory situation of sublinks, subprocesses, and subfields. As early as 1990, the British Parliament formulated the epoch-making “Food Safety Law.” In 2000, the European Union issued the “Food Safety Code,” [12] which also has guiding significance for countries to formulate relevant laws and regulations. The above-mentioned direct screening shows that comprehensive legislation is a new requirement of the new era, and it also reflects that within the scope of the country as a unit. Food safety issues also have inherent requirements in terms of legal standards and regulations.

In 2005, the World Health Organization and the Food and Agriculture Organization of the United Nations defined the safety of food as follows: “in the process of food processing and circulation, it will not cause threats and health damage to the user’s body.” In the 2009 Food Safety Law, the domestic “food safety” replaced “food hygiene” for the first time. Taking into account food hygiene, quality issues, sustainable safety, and other factors, food safety is defined food as follows: [13, 14] “it must be nontoxic and harmless along with the necessary nutrients, and it cannot cause acute, subacute, or chronic harm to the human body.” The newly revised Food Safety Law in 2015 continues to use the concept of “food safety.” Table 1 shows the economic efficiency indicators of the domestic food industry in 2014.

The International Codex Committee on Food Hygiene (CCFH) believes that the safety of food means that the food does not contain harmful substances and there is no risk, i.e., acute poisoning, side effects, or food that does not cause potential diseases when ingested by consumers. It does not contain toxic and harmful substances and factors that may cause acute or chronic poisoning or infection, posing a great threat to consumers’ health. This concept is more comprehensively defined and accepted by
the international community in general, and it has become a consensus on the meaning of food safety.

2.1.3. Big Data Food Safety Supervision. Generally speaking, food safety supervision [15] refers to the effective supervision and management of the whole process of food production and operation of the state and the government in accordance with relevant food safety laws and regulations to ensure the safety of consumers’ diet and consumption and to ensure food production, operation, market standardization, and orderly operation. Regarding the definition of the concept of food safety supervision, various sectors of society have different views and opinions. The definition of the Food and Agriculture Organization of the United Nations and the World Health Organization is as follows: “providing protection for consumers and ensuring the quality of food production, storage, processing, and even sales are necessary management activities implemented by the state or local government. This is safe, complete, and generally applicable. Food labeling should be honest and accurate in accordance with the law.” Scholars have also put forward various opinions on the definition of food safety supervision from various angles. From the point of view of public management, food safety supervision in food production is a kind of government supervision and management of business activities, whose purpose is to better maintain the health and safety of citizens. Some people also believe that this view mainly emphasizes that the government plays a leading role in food safety supervision and management. From an economic point of view, food safety supervision is to ensure the safety of food consumption and the sound operation of the market when the market fails. Some people also think that it is a management activity. This view mainly emphasizes the government’s control of the food market. Figure 2 is a logical diagram of social cogovernance behavior under sufficient supply of big data.

The rapid development of the internet has made available a huge amount of information to the public lacking professional knowledge. Among them, it is difficult to distinguish between fish and dragons. Untrue information has caused the public to distrust the supervisors and evaluation experts and even lose confidence in food safety governance.

2.1.4. The Level of Specialization of Grassroots Grid Staff Is Not High. During the implementation of the “gridization [20]” of grassroots food safety, there is a “comanagement unity” between the food safety coordinator and the safety...
production coordinator, although it improves the management efficiency and realizes a "one network" integration. However, at the same time, it also led to the low degree of professionalism of grid personnel everywhere. Tables 2 and 3 show the age and educational level of the food safety coordinator in a certain county.

In the process of grid arrangement of various levels, there are generally low levels of education of grid personnel, information personnel, and coordinators, and lack of ability to deal with emergency food problems. The more they extend downward, the lower the comprehensive ability of personnel. It is a middle school and high school culture, however, with the extension of the grid level, the problems encountered by the grid specialists at the grassroots level are often more specific, trickier, and more responsible [21]. If one does not increase professional training for this supervision group, one will only rely on intuition. It is difficult to solve the increasingly complex grassroots food problems by ear and hand, and the bottleneck of grid staff's low food safety laws and technical knowledge becomes more obvious after the reform of the food and drug system and the merger of functions. The law involves a wide range of areas, and short-term assault training cannot quickly improve the level of grid personnel. If this group is rushed into battle, it will increase the risk of malfeasance and performance. However, through simple investigations, only simple questions, such as whether the personnel health certificate has expired, whether the production and business unit has a license, the food has expired, whether the environment is clean and sanitary, whether the farmer’s market account is set up, can only be traced and fed back. There is often no way to deal with whether there is illegal addition of nonedible substances or abuse of additives to food, whether it has passed the test, or whether there are major target-oriented sensitive risks, such as mutated bacteria.

2.2. Grid Management under Big Data. Big data [22] is a relatively abstract concept. As the text shows, it means a huge amount of data and data diversification [23]. Wikipedia believes that "big data" refers to large and complex datasets that are difficult to handle with current database management tools and traditional data processing applications of information technology [24, 25]. The trend of big data sets is the additional information obtained from a single big dataset of related data. Compared with different small datasets with the same amount of data, a specific correlation can be found to determine the seed. The currently widely recognized definition of big data should have the five characteristics as shown in Figure 4.

### Table 2: Age composition of food safety coordinators.

| Age group (years old) | Number of people (number) | The proportion (%) |
|-----------------------|---------------------------|--------------------|
| 20–29                 | 20                        | 5.12               |
| 30–39                 | 43                        | 11.00              |
| 40–49                 | 144                       | 36.83              |
| Over 50 years old     | 184                       | 47.06              |

### Table 3: Educational level composition of food safety coordinators.

| Education                  | Number of people (number) | The proportion (%) |
|----------------------------|---------------------------|--------------------|
| Undergraduate and junior college | 21                        | 5.37               |
| High school                | 79                        | 20.20              |
| Junior high school         | 232                       | 59.33              |
| Primary school             | 59                        | 15.10              |

2.2.2.1. BP Neural Network Model and its Basic Principles. The BP neural network [26] is a multi-layer feedforward network trained by the error return attribute algorithm, and it is one of the most widely used neural network models. The BP network can learn and save multiple input-output pattern mapping relationships, without the need to explain the mapping relationship formula in advance. Figure 5 shows the topology of a general 3-layer BP network. The three layers are completely interconnected, and there is no interconnection between the same layers. The hidden layer can have one or more layers. The learning process of BP network is composed of forward calculation and wrong backward attribute process.

2.2.2. Grid Management Topology. Grid supervision [27] is based on network reconfiguration, and it is a supervision mode that divides areas and grids for supervision goals. Through the construction and arrangement of grid supervision areas and processes, a five-level linkage mechanism between government departments, professional institutions, food production, operation units, social groups, and grid members is realized, and the existing food management resources are further integrated to achieve zero. The topology of grid management is shown in Figure 6. The past management mode of public affairs restricted to a certain category [28], along with the rapid development of human civilization process, is becoming less suitable for today’s social management mode. The grid supervision breaks this bottleneck, and its compatibility and openness will.
determine the scale and function of grid management. This concept can maximize the utilization of government resources and can be widely used in all aspects of contemporary life and management. It can be applied to the field of food safety supervision, i.e., the cultivation of agricultural products, food production, processing, circulation, catering, etc. The whole process of orderly monitoring of many links can not only control the quality of food from the source but also investigate and issue the problem link the first time when a food safety problem occurs, control the problem, solve the problem, and reduce the radiation surface of the incident.

2.3. Design of Evaluation Index for Failure Rate. The current nonconformance rate evaluation carried out by the regulatory authorities [29] is for the overall nonconformity rate of food samples, which cannot meet the regulatory needs of the regulatory authorities for specific types of hazardous substances in food. This article believes that the design risk coefficient focuses on the unqualified status of a certain type of parameter to be tested and specific parameters to be tested, as the input of the supervision activities in the next cycle. To this end, this article will proceed to sink the research on the failure rate to the most basic, specific to each parameter to be tested, and construct an evaluation method for the risk coefficient of a specific single parameter to be tested. Although the amount of data involved in this work will be greatly increased compared to the past, it can be easily achieved in today’s rapid development of big data technology.

2.3.1. The Copy Creation Algorithm in the DHRA Copy Management Strategy. The copy selection algorithm of the DHRA copy management strategy [30] defines the copy response time RT in the copy selection. RT is mainly used to calculate the copy time of the copy out of the node on the node, and it mainly involves the physical copy of the copy itself.

\[ RS = S_1 + S_2. \]  

In the formula, S1 is the physical copy delay of the storage unit and S2 is the waiting delay of the request queue.

\[ S_1 = \frac{\text{FileSize (MB)}}{\text{Storage Speed (MB/s)}}. \]  

In the formula, FileSize is the file size, and StorageSpeed is the physical copy speed of the storage unit.

\[ S_2 = \sum_{i=1}^{n} S_1. \]  

In the formula, n is the number of files in the waiting queue for copying. When selecting a copy, the storage unit with the smallest RS is selected as the best copy storage unit.

2.3.2. The Unqualified Rate of a Specific Parameter to be Tested in the Same Type of Food Sample. In this paper, the unqualified rate of the parameters to be tested [31] is designed as an evaluation index based on the comparison between the measured values of the parameters to be tested and the national legal standard values at all levels. In the collection of all batches of this type of food (using the power of meat products), the proportion of the actual test value of the specific parameter (the amount of nitrite residue in the food additive item) is calculated to obtain the unqualified rate of the specific item. To understand this risk coefficient evaluation system intuitively, the paper, firstly, describes the set of batches as follows: a food batch is \( N_i \), and there are multiple types of inspection items for a food batch, which are recorded as a total of \( i \), and at the same time. There are also multiple single parameter records to be tested under a certain type of parameter to be tested. There are \( j \) in total. Then, each specific parameter to be tested is expressed as \( A_{ij} \). \( L_{ij} \) is the actual measured value of each specific parameter to be tested, and \( U_{ij} \) is used to represent all batches of the food.

\[
\text{Input layer} \xrightarrow{\text{Hidden layer}} \text{Output layer}
\]

\[
\text{Hidden layer output } O_j
\]  

\[
\text{Output amount } X_j
\]  

\[
\text{Output layer output } Y_j
\]

\[
\text{Figure 5: Typical BP network model.}
\]
For the number of unqualified counts of all measured results in the set, \( \text{Min}_{ij} \) and \( \text{Max}_{ij} \) are the minimum limit value and the maximum limit value required by the standards of the corresponding project, respectively.

Firstly, calculate the unqualified number \( U_{ij} \) of the specific parameters to be tested in all batches of this type of food. The unqualified number is the statistics of the unqualified records.

(i) \( \text{If } \text{Min}_{ij} = 0, L_{ij} = 0, \text{ and the single item judgment result of the parameter to be tested is qualified, then } U_{ij} = 0 \)

(ii) \( \text{If } \text{Min}_{ij} \leq L_{ij} \leq \text{Max}_{ij} \text{ and the single item judgment result of the parameter to be tested is qualified, then } U_{ij} = 0 \)

(iii) \( \text{If } L_{ij} < \text{Min}_{ij} \text{ and the single item judgment result of the parameter to be tested is unqualified, then } U_{ij} = 1 \)

(iv) \( \text{If } L_{ij} > \text{Max}_{ij} \text{ and the single item judgment result of the parameter to be tested is unqualified, then } U_{ij} = 1 \)

In this way, in all batches of this type of food, each specific parameter being tested has a corresponding non-modified value (value “0” or “1”).

Then, calculate the failure rate \( X_{ij} \) of the specific test parameter \( A_{ij} \) of this type of food on all batches. Group all batches of this type of food and divide the total number of unqualified samples for each specific parameter group by the collection of all batches. This type of food will test the total number of parameters in each batch of food, and the unqualified rate \( A_{ij} \) for testing specific parameters is recorded as \( X_{ij} \) as follows:

\[
X_{ij} = \frac{\sum U_{ij}}{n_{ij}}
\]

In the formula, \( n_{ij} \) is the total number of food batches for the \( j \text{th} \) specific parameter to be tested in the \( i \text{th} \) type of food batches.

2.3.3. The Unqualified Rate of the I-type Parameter to be Tested for a Certain Type of Food. Firstly, calculate the unqualified number of the \( i \text{th} \) parameter type set to be tested in all batch sets of a certain type of food. The unqualified number of parameter types to be tested is a statistical number of the number of unqualified items in a certain type of parameter type to be tested.

\[
X_i = \begin{cases} 
0, & \text{when } \sum_{j} A_{ij} = 0, \quad j = 1, 2, \ldots, J, \\
1, & \text{when } \sum_{j} A_{ij} = 1, \quad j = 1, 2, \ldots, J.
\end{cases}
\]

Then, calculate the unqualified rate \( X_i \) of the \( i \text{th} \) type to be tested parameter \( A_i \) in all batches of the \( k \text{th} \) food set.

\[
X_i = \frac{\sum U_{ij}}{n_i}
\]

In the formula, \( n_i \) is the number of food batches of the \( i \text{th} \) parameter to be tested in the \( k \text{th} \) food batch.

2.3.4. The Unqualified Rate \( U \) of This Type of Food. Firstly, calculate the number of unqualified batches of \( k \text{th} \) food \( X \). As long as a batch has a test parameter \( X_{ij} \) that is
unqualified, a batch is unqualified. Only if all test parameters $X_{ij}$ are qualified, a batch is qualified.

$$U = \begin{cases} 
0, & \text{when } \sum_{j} \sum_{j} A_{ij} = 0, \quad j = 1, 2, \ldots, J, \\
1, & \text{when } \sum_{j} \sum_{j} A_{ij} = 1, \quad j = 1, 2, \ldots, J.
\end{cases}$$

(7)

As long as there is a batch of unqualified parameter types $X_j$, a batch is unqualified. Only if all the parameter types set $X_j$ are qualified, a batch is qualified.

$$U = \begin{cases} 
0, & \text{when } \sum_{j} A_{ij} = 0, \quad j = 1, 2, \ldots, J, \\
1, & \text{when } \sum_{j} A_{ij} = 1, \quad j = 1, 2, \ldots, J.
\end{cases}$$

(8)

In all batches of this type of food, each batch corresponds to a nonconforming number (value is "0" or "1"), and statistics can be used to obtain the nonconforming batch in all batches of this type of food. Total (denoted as $m$) is as follows:

$$m = \sum_{n=1}^{n} U.$$  

(9)

In the collection of all batches of a specific type of food, the total number of unqualified batches is divided by the number of batches $n$ to obtain the unqualified rate $U$.

$$X = \frac{\sum_{n=1}^{n} U}{n}.$$  

(10)

2.3.5. Overall Unqualified Rate of Food $Z$. If the major food categories included in the risk assessment have $K$ categories, the number of samples for each category of batches is $n$. According to the above statistics of the total number of unqualified batches of category $k$ food,

$$m_{k} = \sum_{n=1}^{n} X.$$  

(11)

Corresponding to the total sampling batch of products, $n_{k}$, the overall nonconformity rate of this type of food is recorded as $Z$. Then,

$$Z = \frac{\sum_{k=1}^{K} m_{k}}{\sum_{k=1}^{K} n_{k}}.$$  

(12)

2.4. Establishment of Evaluation Indicators for the Degree of Nonconformity. The "nonconformity" index [32] refers to the degree of the content of the inspected item in the food compared to the standard limit value, and it clarifies the degree of the risk of food unrest that may be caused by the target substance in the food. It is represented by the variable "$Y$," i.e., the variable "$Y$" is a function of the degree relative to the standard value. The unqualified degree of the test parameters designed in this paper is an index based on the ratio of the measured value of the test parameter to the standard value, which clarifies the content of the detected substance in the food compared with the safety. Restrictions and nonconformance rates clearly deviate from safety standards. The combination of the two can more comprehensively characterize the possibility of food safety risks.

In the testing items, the difficulty of producing evidence in litigation for rights protection is an example. Because of the lack of an inversion system of the burden of proof for food safety and the current problems of "uninspected openings" in the country and many testing institutions not accepting individual citizens’ submissions for inspection, it is difficult for consumers to produce evidence.

2.4.1. The Unqualified Degree $Y$ of a Specific Parameter to be Tested in the Set of All Batches of a Certain Type of Food. In the collection of all batches of a certain type of food, calculate the degree to which the actual value of a specific item deviates from the standard limit value. Use $Y_{ij}$ to indicate the degree to which the actual detection value $L_{ij}$ of the specific test parameter $A_{ij}$ of the $i$th category in all batches of this type of food deviates from the standard limit value $(\text{Min}_{ij}, \text{Max}_{ij})$, and the calculation method is as follows:

(i) \(\text{①} \) If $\text{Min}_{ij} = 0$, $L_{ij} = 0$, and the single item judgment result of the parameter to be tested is qualified, then $Y_{ij} = 0$

(ii) \(\text{②} \) If $\text{Min}_{ij} < L_{ij} < \text{Max}_{ij}$ and the single item judgment result of the parameter to be tested is qualified, then $Y_{ij} = 0$

(iii) \(\text{③} \) If $L_{ij} < \text{Min}_{ij}$ and the single item judgment result of the parameter to be tested is unqualified, then $Y_{ij} = 1$

(iv) \(\text{④} \) If $L_{ij} > \text{Max}_{ij}$ and the single item judgment result of the parameter to be tested is unqualified, then $Y_{ij} = 1$

To facilitate the calculation of the $Y_{ij}$ value of $L_{ij}$ relative to $\text{Min}_{ij}$ and $\text{Max}_{ij}$ and to ensure that its value range is within the range of qualified and unqualified values, i.e., it belongs to $(0, 1)$,

$$V_{ij} = \begin{cases} 
1 - \frac{L_{ij}}{\text{Min}_{ij}}, & 0 < L_{ij} < \text{Min}_{ij}, \\
1 - \left(\frac{L_{ij}}{\text{Max}_{ij}}\right)^{-1}, & L_{ij} > \text{Max}_{ij} > 0.
\end{cases}$$

(13)

In this way, in the collection of all batches of a certain category of food, the actual measured value of each specific inspected item has a nonconforming deviation degree value corresponding to it $(0 \leq Y_{ij} \leq 1)$. In this way, the $i$th type of parameter to be tested is the $j$th. The number of food batches for a specific parameter to be tested is $n_{ij}$, and the unqualified
degree (denoted as $Y_{ij}$) of the specific parameter to be tested is as follows:

$$Y_{ij} = \frac{\sum_{j=1}^{i} V_{ij}}{n_{ij}}. \quad (14)$$

In the formula, $n_{ij}$ is the number of food batches of the $i^{th}$ type of parameter to be measured for this type of food batch. The number of food batches of the $j^{th}$ specific parameter to be measured can be seen from the calculation formula of $Y_i$. The numerator and denominator are all data with exactly the same nature, so its ratio is also just a value, which indicates the deviation from the standard limit, and it does not contain any other information. Since this article uses the form of ratio to characterize the degree of deviation of the measured value from the standard limit, $0 \leq Y_{ij} \leq 1$, it can be foreseen that the greater the $Y_{ij}$ value, the greater the potential risk, and the more unsafe the food.

2.4.2. The Unqualified Degree $Y_i$ of the I-type Parameter $A_i$ of a Certain Type of Food. The number of samples for a certain type of food is determined to be $n$. There are $i$ types of parameters to be tested for this type of food batches, and the $i^{th}$ type of parameters to be tested for this type of food batches have specific parameters to be tested $j$. On the basis of $Y_{ij}$, calculate the unqualified degree $Y_i$ of the $i^{th}$ category parameter $A_i$ of this type of food.

$$Y_i = \frac{1}{n_i} \sum_{j=1}^{i} V_{ij}. \quad (15)$$

2.4.3. Unqualified Degree $Y$ of a Certain Type of Food. On the basis of $Y_i$, calculate the unqualified degree of this type of food (denoted as $Y$). $Y$ is a function of $Y_{ij}$: $Y = F(Y_{i1}, Y_{i2}, \ldots)$. Calculate $Y$ based on the same reason that the unqualified degree is evaluated according to the food safety standard limit value without considering the following factors: the degree of toxic hazard caused by various parameters (hazards) ingested into the human body and the superimposed effect have been taken into account when formulating the limits of food safety standards. The nonconformity evaluation carried out according to food safety standards does not need to reconsider the weight again, and the nonconformity degree $Y$ of this type of food can be obtained using a simple arithmetic average method.

$$Y = \frac{1}{I} \sum_{i=1}^{I} Y_i. \quad (16)$$

2.4.4. The Overall Unqualified Degree of Food $\bar{Z}$. There are $K$ categories of foods sampled and inspected by a supervisory authority. The number of samples for each type of food batch is $n_k$. The overall unqualified degree of all products involved in the supervision is recorded as $\bar{Z}$. Then,

$$\bar{Z} = \frac{1}{K} \sum_{k=1}^{K} Y_k. \quad (17)$$

Among them, $\bar{Z} \in (0, 1)$. Through the above design, this paper has established a set of food safety risk evaluation index systems based on regulatory needs [33]. See Table 4.

From Table 4, it can see the statistical evaluation of food failure rate and related information. Set up an independent department to carry out relevant work, disclose substandard food in a timely manner, and provide healthy guidance for consumers to make purchasing choices to eliminate or reduce the information asymmetry between food suppliers and food consumers.

2.5. Calculation Method of Food Risk Coefficient Variables. In the food safety risk coefficient coordinate space [34] constructed in this paper, the “origin O” is on the plane coordinate axis. It indicates the qualified state of the test value of the food parameter being tested, regardless of whether it is expressed in a nonqualified rate or nonqualified degree, and it is represented by a value of “0.” Therefore, the geometric distance $OL$ between the punctuation point and the origin on the plane can characterize the state of its risk factors. The longer the $OL$ distance, the higher the risk factors and the worse the food safety.

To specifically characterize the absolute distance from the safe state of the “origin O” to the object, this article defines the geometric distance based on the definition of geometric distance and uses the distance from the coordinate point to the origin to define the “unqualified rate” and “unqualified degree.” The risk coefficient of the two-dimensional space, i.e., the calculation method of “square root of the sum of squares,” is used to construct the risk coefficient. Therefore, the calculation formula for the evaluation result of the food risk coefficient of the specific parameter ($j^{th}$, etc.) of the test object is as follows:

$$L_{ij} = \sqrt{X_{ij}^2 + Y_{ij}^2}. \quad (18)$$

By analogy, the calculation formula for the risk coefficient of a certain type of parameter to be tested and a certain type of food can be obtained as follows:

The risk coefficient of the $i^{th}$ type of parameter to be tested is as follows:

$$L_i = \sqrt{X_i^2 + Y_i^2}. \quad (19)$$

The risk factor of a certain type of food is as follows:

$$L_e = \sqrt{X_e^2 + Y_e^2}. \quad (20)$$

The food risk factor for all data sources is as follows:

$$\bar{L} = \sqrt{\bar{Z}^2 + \bar{Z}^2}. \quad (21)$$

The various levels of safety indicators proposed in this article have clear and consistent meanings. The characteristics of the food risk coefficient are the nonconforming rate
and the degree of nonconforming food, which can be called "food risk coefficient" [35]. Through the above-mentioned food risk coefficients, the supervision department can perform effective and feasible mathematical statistics on the regional food safety status based on the parameter data sampled from the test objects and obtain the comprehensive evaluation information of 3 levels.

3. Big Data Grid Management Experiment Test

By designing a platform based on the collection, query, search, and filtering of big data [36], given a limited range of values, food safety can be controlled. The main function is to put the country’s food safety information traceability system in the environment of food safety collaborative governance. Therefore, the institutional cooperation of related auxiliary links cannot be ignored, such as the construction of the whole-process supervision system of the food safety chain and the unification of food safety, the construction of the labeling system, the labeling system of agricultural products, and the food recall system. The grid management layout is used to screen various food indicators to finally achieve the goal. The experimental test will be carried out below.

3.1. Training Test. Train () before applying the function to train the network. The network training parameters must be set in advance. The training time is set to 1000. The training accuracy is set to 0.001, and the remaining parameters use default values. The error change process obtained after training is shown in Figure 7.

Use the trained big data test to make predictions, draw the data output curve, and compare it with the original nonlinear function curve and the output result curve of the untrained network. The result of the comparison is shown in Figure 8.

It can be seen from the fitting graph of the predicted output of the big data predicted risk coefficient, the expected value, and the error graph that the predicted value risk coefficient is basically the same as the actual calculated risk coefficient, and the error and error percentage are relatively small and controlled between 2%, which shows that the big data is effective to predict the food safety risk coefficient. Table 5 shows the actual application results.

4. Experimental Results and Analysis

The experiment was conducted on the Optorsim grid simulation platform [37], the environment configuration parameters were unchanged, and the number of jobs were 300, 600, 900, 1200, 1500, 1800, and 2100 in seven different situations. The simulation experiment is divided into four copy management strategies: LRU copy management strategy, LFU copy management strategy, DHRA copy management strategy, and LWLC copy management strategy. According to the unified standard, establish a unified risk monitoring result database and include the monitoring and evaluation food sampling results of each unit into the database. Through mechanism construction and risk communication, assessment and management will be integrated into an organic whole that fully plays its role. The results of the experiment are shown in Figure 9.

On the Optorsim grid simulation platform, the environment configuration parameters have not changed. The storage unit capacity is 30 GB, 40 GB, 50 GB, 60 GB, 70 GB, 80 GB, 90 GB, and 100 GB in eight cases. Figure 10 shows the LRU copy management strategy, LFU copy management strategy, DHRA copy management strategy, and LWLC copy management strategy, which are the 4 simulation experiment results of copy management strategies.

As shown in Figure 10, as the storage unit capacity increases, the simulation results of these four data grid dynamic replication algorithms show that the average time to complete the job is also continuously decreasing. When the storage capacity is large, the average time to complete the job is basically the same. When the storage capacity is small, the LWLC copy management strategy and the DHRA copy management strategy are faster than the other two copy management strategies. However, the LWLC copy management strategy is better than the DHRA copy management strategy, and this advantage is significantly weakened as the storage unit capacity increases. It can be seen that when the storage unit capacity is small, the average job execution time of the LWLC copy management strategy is shorter than the average job execution time of the LRU copy management strategy, LFU copy management strategy, and DHRA copy management strategy. However, when the storage capacity of the storage unit is large, the advantages of the LWLC copy management strategy and the DHRA copy management strategy are less obvious than the other two copy management strategies, and the average operation time is

| Food safety evaluation index | Failure rate | Unqualified |
|----------------------------|-------------|------------|
| Parameters to be measured  | The unqualified rate of the jth parameter to be tested in the ith category in the food | The unqualified degree of the jth parameter to be tested in the ith category in the food |
| Project type               | The unqualified rate of the ith parameter to be tested in the food | The unqualified degree of the ith type of parameter to be tested in the food |
| Food category              | The unqualified rate of this category of food | The unqualified degree of this category of food |
| Estimated proportion       | 96.1564%    | 95.9413%   |

Table 4: Table of a certain category of food safety evaluation index system.
even longer than the other two copy management strategies.

First of all, the number of food safety cases has been decreasing year by year, which shows that China’s food safety problems have eased, however, the amount involved has increased, indicating that the scale of the cases is large and the scope of influence is wide, and the increase in the number of cases transferred to judicial organs also shows from one aspect that the severity of the cases has increased, as shown in Table 6.

From Table 6, it can be seen that the objective existence of power imbalance in various aspects in the process of

| Serial number | Test items       | unit  | Standard value | Measured value | Individual judgment |
|---------------|------------------|-------|----------------|----------------|---------------------|
| 1             | Lead             | mg/kg | <0.5           | 0.2            | Qualified           |
| 2             | Cadmium          | mg/kg | <0.1           | 0.05           | Qualified           |
| 3             | Chromium         | mg/kg | <1.0           | 0.5            | Qualified           |
| 4             | Total arsenic    | mg/kg | <0.5           | 0.2            | Qualified           |
| 5             | N-Dimethylnitrosamine | mg/kg | <3.0           | 1.0            | Qualified           |
| 6             | Nitrite          | mg/kg | <30            | 12             | Qualified           |
| 7             | POV              | g/100g| <0.50          | 0.36           | Qualified           |
actual governance leads to the limited supply of resources in the system, and subjective factors, such as concepts and mechanisms, work together to cause internal imbalances. Food safety governance is limited by strict policies, lack of supervision, structural imbalances, and dilemma. To build a cogovernance platform for all parties in food safety governance through the redistribution of political resources, it is necessary to start with new theories, build a new dynamic model, reposition the main body of food safety governance, and innovate and optimize the operating mechanism. Combining the distribution of rights and obligations in the sense of risk is the key to stabilizing public

---

**Table 6**: Investigation and handling of food cases by China’s State Food and Drug Administration from 2017 to 2020.

| Years | Investigate and deal with food cases (cases) | Amount involved (ten thousand yuan) | Number of cases transferred to judicial organs (cases) |
|-------|---------------------------------------------|--------------------------------------|------------------------------------------------------|
| 2018  | 120342                                      | 14364.9                              | 1011                                                 |
| 2019  | 137934                                      | 20675.5                              | 1314                                                 |
| 2020  | 158939                                      | 27434.8                              | 1403                                                 |
behavior choices, reducing psychological fear, and achieving public welfare goals.

5. Conclusions

With the progression of time, big data has slowly entered people’s eyes, and the ability of big data to process data has also made people realize its importance. As people’s lives become more abundant and the control of food safety becomes more stringent, this article mainly studies a food safety assurance method based on the background of big data and grid management. Through the big data collection of the traceable data of platform food information attributes, food indicators are obtained from different regional grids, and qualified foods are screened under the failure rate of 2%. With the increase of the number of times and the increase of the storage unit capacity, the experiment operation time becomes shorter and the error becomes smaller.

Data Availability

The data that support the findings of this study are available from the corresponding author upon reasonable request.

Conflicts of Interest

The authors declare that there are no conflicts of interest with respect to the research, authorship, and/or publication of this article.

Acknowledgments

The study was supported by the National Social Science Fund of China (20BGL129).

References

[1] J. Wang, W. Liu, S. Kumar, and S. F. Chang, "Learning to hash for indexing big data—a survey," Proceedings of the IEEE, vol. 104, no. 1, pp. 34–57, 2016.

[2] Y. Zhang, M. Qiu, C. W. Tsai, M. M. Hassan, and A. Alamri, "Health-CPS: healthcare cyber-physical system Assisted by cloud and big data," IEEE Systems Journal, vol. 11, no. 1, pp. 88–95, 2017.

[3] E. Baccarelli, N. Cordeschi, and A. Mei, "Energy-efficient dynamic traffic offloading and reconfiguration of networked data centers for big data stream mobile computing: review, challenges, and a case study," Computers and Chemical Engineering, vol. 91, no. 2, pp. 182–194, 2016.

[4] V. Zettl, M. H. Ahmad, T. Beltramo et al., "Supervision of food manufacturing processes using optical process analyzers—an overview," Chembioeng Reviews, vol. 3, no. 5, pp. 219–228, 2016.

[5] H. Y. Lee, J. H. Choi, N. Y. Yi et al., "Development of materials for food safety and nutrition management program for single seniors with a life manager - by focus group interview and delphi technique - by focus group interview and delphi technique," Journal of the Korean Society of Food Science and Nutrition, vol. 47, no. 2, pp. 195–206, 2018.

[6] W. Dzwolak, "Practical aspects of traceability in small food businesses with implemented food safety management systems," Journal of Food Safety, vol. 36, no. 2, pp. 203–213, 2016.

[7] A. Anvari-Moghaddam, J. M. Guerrero, J. C. Vasquez, H. Monsel, and A. Rahimi-Kian, "Efficient energy management for a grid-tied residential microgrid," IET Generation, Transmission and Distribution, vol. 11, no. 11, pp. 2752–2761, 2017.

[8] Z. Yi, S. Li, and R. Tan, "Distributed model predictive control for on-connected microgrid power management," IEEE Transactions on Control Systems Technology, vol. 26, no. 99, pp. 1028–1039, 2017.

[9] D. Specht, "Book review: the data revolution: big data, open data, data infrastructures and their consequences," Media, Culture and Society, vol. 37, no. 7, pp. 1110–1111, 2015.

[10] M. Zaharia, R. S. Xin, P. Wendell et al., "Apache spark: a unified engine for big data processing," Communications of the ACM, vol. 59, no. 11, pp. 56–65, 2016.

[11] Z. Obermeyer and E. J. Emanuel, "Predicting the future — big data, machine learning, and clinical medicine new England," Journal of Medicine, vol. 375, no. 13, pp. 1216–1219, 2016.

[12] E. D. Siew, R. K. Basu, and H. Wunsch, "Optimizing administrative datasets to examine acute kidney injury in the era of big data: workshop statement from the 15th ADQI Consensus Conference," Canadian Journal of Kidney Health and Disease, vol. 3, no. 1, pp. 1–12, 2016.

[13] M. Adil, M. K. Khan, M. Jamjoom, and A. Farouk, "MHADBOR: ai-enabled administrative distance based opportunistic load balancing scheme for an agriculture internet of things network," IEEE Micro, vol. 42, 2021.

[14] S. Topal, F. Tas, S. Broumi, and O. A. Kirecci, "Applications of neutrosophic logic of smart agriculture via internet of things," International Journal of Neutrosophic Science, vol. 12, no. 2, pp. 105–115, 2020.

[15] H. Stevens, "Big data, little data, No data: scholarship in the networked world," Journal of the Association for Information Science & Technology, vol. 67, no. 3, pp. 731–753, 2016.

[16] I. Tomasević, N. Šmigić, and I. Dekić, "Evaluation of food safety management systems in Serbian dairy industry," Mijekarstvo, vol. 66, no. 1, pp. 48–58, 2016.

[17] A. Xl and L. A. Hao, "Big data analysis of the internet of things in the digital twins of smart city based on deep learning," Future Generation Computer Systems, vol. 128, pp. 167–177, 2021.

[18] C. A. Tavera Romero, J. H. Ortiz, O. I. Khalaf, and A. Rios Prado, "Business intelligence: business evolution after industry 4.0," Sustainability, vol. 13, no. 18, Article ID 10026, 2021.

[19] P. Pressman, A. S. Naidu, and R. Clemens, "COVID-19 and food safety: risk management and future considerations," Nutrition Today, vol. 55, no. 3, pp. 125–128, 2020.

[20] R. Wang, P. Wang, and G. Xiao, "Intelligent Microgrid Management and EV Control under Uncertainties in Smart Grid || Summary and Future Work," 2018.

[21] X. Li and Y. Sun, "Stock intelligent investment strategy based on support vector machine parameter optimization algorithm," Neural Computing & Applications, vol. 32, no. 6, pp. 1765–1775, 2020.

[22] L. Karam, T. Salloum, R. El Hage, H. Hassan, and H. F. Hassan, "How can packaging, source and food safety management system affect the microbiological quality of spices and dried herbs? The case of a developing country," International Journal of Food Microbiology, vol. 353, no. 6, Article ID 109295, 2021.
[23] C. Palomino-Camargo, Y. Gonzalez-Munoz, E. Perez-Sira, and V. Hugo Aguilar, “Metodología Delphi en la gestión de la inocuidad alimentaria y prevención de enfermedades transmitidas por alimentos,” Revista Peruana de Medicina Experimental y Salud Pública, vol. 35, no. 3, pp. 483–490, 2018.

[24] M. Ismail, “Mobile cloud database security: problems and solutions,” Fusion: Practice and Applications, vol. 7, no. 1, pp. 15–29, 2021.

[25] S. P. Paul and D. S. Aggarwal, “A cognitive research tendency in data management of sensor network,” International Journal of Wireless and Ad Hoc Communication, vol. 3, no. 1, pp. 26–36, 2021.

[26] W. Yashi, G. Ren, and H. Zhen, “Establishment of evaluation system on food safety management capacity for food production enterprises by Delphi method,” Zhong nan da xue xue bao. Yi xue ban-Journal of Central South University, vol. 44, no. 4, pp. 437–443, 2019.

[27] G. L. Liggans, M. S. Boyer, L. B. Williams, K. W. Destromp, and S. T. Hoang, “Food safety management systems, certified food protection managers, and compliance with food safety practices associated with the control of Listeria monocytogenes in foods at restaurants,” Journal of Food Protection, vol. 82, no. 7, pp. 1116–1123, 2019.

[28] K. Zheng, Z. Yang, K. Zhang, P. Chatzimisios, K. Yang, and W. Xiang, “Big data-driven optimization for mobile networks toward 5G,” IEEE Network, vol. 30, no. 1, pp. 44–51, 2016.

[29] M. M. U. Rathore, A. Paul, A. Ahmad, B. W. Chen, B. Huang, and W. Ji, “Real-time big data analytical architecture for remote sensing application,” Ieee Journal of Selected Topics in Applied Earth Observations and Remote Sensing, vol. 8, no. 10, pp. 4610–4621, 2015.

[30] Y. Wang, L. A. Kung, and T. A. Byrd, “Big data analytics: understanding its capabilities and potential benefits for healthcare organizations,” Technological Forecasting and Social Change, vol. 126, pp. 3–13, 2018.

[31] H. Xing, A. Qian, and R. C. Qiu, “A big data architecture design for smart grids based on random matrix theory,” IEEE Transactions on Smart Grid, vol. 8, no. 2, pp. 674–686, 2017.

[32] E. Zeydan, E. Bastug, M. Bennis et al., “Big data caching for networking: moving from cloud to edge.” IEEE Communications Magazine, vol. 54, no. 9, pp. 36–42, 2016.

[33] L. Kuang, F. Hao, L. T. Yang, M. Lin, C. Luo, and G. Min, “A tensor-based approach for big data representation and dimensionality reduction,” IEEE Transactions on Emerging Topics in Computing, vol. 2, no. 3, pp. 280–291, 2014.

[34] M. Janssen, H. van der Voort, and A. Wahyudi, “Factors influencing big data decision-making quality,” Journal of Business Research, vol. 70, pp. 338–345, 2017.

[35] K. Wang, Y. Shao, L. Shu, C. Zhu, and Y. Zhang, “Mobile big data fault-tolerant processing for ehealth networks,” IEEE Network, vol. 30, no. 1, pp. 36–42, 2016.

[36] S. Akter, S. F. Wamba, A. Gunasekaran, R. Dubey, and S. J. Childe, “How to improve firm performance using big data analytics capability and business strategy alignment?” International Journal of Production Economics, vol. 182, no. DEC, pp. 113–131, 2016.

[37] R. Dubey, A. Gunasekaran, S. J. Childe, S. F. Wamba, and T. Papadopoulos, “The impact of big data on world-class sustainable manufacturing,” International Journal of Advanced Manufacturing Technology, vol. 84, no. 1-4, pp. 631–645, 2016.