

Study on food safety regulatory evaluation in China

Jun Gao

*Department of Government and Public Administration, The Chinese University of Hong Kong,
Hong Kong 999077, Hong Kong*

*Corresponding author: gouzeon@hotmail.com

Keywords: Food Safety; Regulation evaluation; Index System

Abstract: As a necessity of human life, the soundness of food safety mechanism is closely related to people's living quality. With the constant change of people's mentality, more attention is paid to the living standard and level of food safety, yet the current level of food safety cannot meet people's demand, which has led to a growing gap between the current situation of food safety and consumers' demand. Therefore, the level of food safety regulation needs to be measured urgently. Based on the stakeholder theory, this paper analyzes the relevant behaviors of stakeholders in the process of food safety regulation, designs the corresponding index system of food safety regulation level, and designs the index weight with the analytic hierarchy process so as to construct the evaluation index system for the level of food safety regulation.

1.Introduction

The characteristics of experience and trust product of food lead to the asymmetry of information, which makes consumers unable to obtain relevant information of food before buying it. Consumers' consciousness of risk decreases when they buy food, and most of them choose and buy based on their experience, which directly affects their purchasing behavior. At the same time, as people's ideas are constantly changing, more attention is paid to the level of food safety. Limited by the food provided by sellers, the current quality of food safety cannot meet people's demand, leading to the phenomenon of lemon market, where consumers choose food with lower price but with no guarantee of quality. This has led to a vicious circle in the entire food production market. The gap between the current situation of food safety and the consumers' needs is getting larger and larger, causing the phenomenon of market failure. Therefore, food safety regulation is indispensable. The regulation of food safety is the only way to ensure food safety, make up for market failure, establish food safety market and improve people's living standard.

However, the current situation of food safety in China is worrying. Taking Shandong Province as an example, according to the statistics of Shandong Provincial, in the first half of 2018, 22,881 complaints and reports of various products were accepted in Shandong Province, among which

18,505 were reports of food, accounting for the largest proportion in the total number of complaints and reports. Among them, 9,164 reports were on food production and processing, and 5,598 reports were on the catering industry. The new *Food Safety Law* re-established the regulatory system of food safety, and sets strict regulatory system for every link in the whole process of food from production to the dining table. In particular, it further refined the regulation of food additives involved in the food production and processing process, improved the system of production process control and management, and emphasized the main responsibility and regulatory responsibility of food producers and traders. Various provinces have also worked hard to solve prominent food safety issues and build a system of social co-governance. However, the situation of food safety is still worrying, and the performance of food safety regulation is questionable. Therefore, the establishment of the index system for food safety regulation level has become the research question of this paper.

2. Literature Review

2.1 The measurement of food safety regulation

In terms of the measurement of food safety regulation, most scholars conduct research from the perspective of cost-benefit framework and food safety risks. In view of the reality that micro data could not be obtained, and based on the application of Delphi method, Henson(1997) put forward an idea to infer the effect of food safety regulation on the basis of the original data. Golan and Vogel(2000) used SAM method in the CGE model to conduct cost-benefit analysis, and analyzed the relationship between regulatory costs and benefits borne by groups at different income levels. This study can be used for reference in the study of food safety regulation in China. Antle(1999,2001) put forward an idea of cost-benefit analysis for the evaluation of food safety regulation effect. The method was a basic research framework of food-safety cost-benefit analysis based on the model of consumers' food demand and the model of food supply. Sylvain Charlebois (2008), a Canadian researcher of food safety system, established an evaluation system for food safety performance in relevant countries and regions in the world with specific regulatory affairs as the dimensions and corresponding input-output index system by combining the regulation process and results.

Scholars have different studies in this field. Some scholars have built relevant index system based on the study of relevant influencing factors of regulation to evaluate the performance of food safety regulation. With DEA, Wang (2011) designed the index of input and output of food safety regulation, evaluated the efficiency of food safety regulation in China from both horizontal and vertical dimensions, and put forward that the efficiency of food safety regulation in China would be improved year by year. Lei and Wu (2011) regarded food safety regulation as a key factor of food safety, and established an early warning system of food safety to measure the effect of food safety regulation. Zhang and Zhang (2014) combined the method of propensity score matching with the method of double difference to evaluate the indirect effects of government' regulation on dairy products.

With the help of micro survey data, some scholars try to study the effects of food safety regulation from different perspectives. From the perspective of enterprises, Bai et al. (2005) discussed the main factors that motivate China's food production and processing enterprises based

on the certification of HACCP food safety management system through enterprise investigation. Based on the survey data of 482 enterprises, Wang Zhigang (2006) analyzed the impact of HACCP certification on the effectiveness of enterprise operation and enterprise cost and income, and demonstrated the relevant influencing factors for enterprises to obtain the certification. Based on relevant research data, Liu et al. (2008) analyzed the influencing factors and costs of the adoption of HACCP in food enterprises in Beijing.

From a macro perspective, and based on the analysis and measurement of China's food safety changes from 1990 to 2010, Liu (2010) further put forward his own explanatory hypothesis, and evaluated the effect of food safety regulation in China. Based on the data of food safety survey in 9 provinces (cities), Liu (2008) analyzed the factors influencing the effect of food safety control in China from the perspectives of government control, producer control, consumer control and scientific and technological control. In order to make a systematic analysis of food safety incidents in the past ten years, Liu et al. (2011) divided the food supply chain into multiple steps and links, and classified the causes of food safety issues, thus constructing a positioning and discrimination matrix for food quality and safety, and systematically analyzed the food safety incidents occurred in the past ten years. Hu (2011) selected related links of food safety and constructed a variable index system including industrial signals, local governments, central government and consumers, elaborated the factors affecting the enforcement of food safety regulation in China, and then proposed that more attention should be paid to rural consumers and the central regulation should be strengthened. From the perspective of agricultural product producers, Zhou (2006), Hu (2009), Sun et al. (2011) analyzed farmers' cognition of agricultural product quality and safety and their compliance behaviors in production safety, studied the factors that promote farmers' quality control of agricultural products and the motivation mechanism for agricultural production and processing enterprises to implement safety production. Han et al. (2011) and Ye (2012) proposed to strengthen government support, increase policy subsidies, and implement a clear food safety responsibility system to drive food production enterprises to implement food traceability system.

2.2 Study on the establishment of measurement index system for food safety regulation

As for the measurement of food safety regulation, scholars have established relevant measurement index systems from different perspectives.

British scholars first studied the factors affecting food safety (2005), producer and consumer behaviors, evaluation indicators of food safety status (2013), government regulation behaviors and methods, etc. In terms of relevant evaluation of government performance, the US National Performance Evaluation Committee (2003) proposed an evaluation system of government performance covering six aspects: output, input, energy, results, productivity and efficiency, and cost-effectiveness. Sylvain Charlebois (2008) et al, scholars at Research Network in Food System, a food safety organization in Canada, attempted to construct output-input indexes from the perspectives of food traceability, biological safety and management, governance and recall, as well as consumer issues, and evaluated and ranked the food safety performance of 16 regions and countries in the world. This evaluation index system made a specific analysis of relevant regulatory issues, and combined the regulatory process and results through the establishment of input-output index system, which has a strong guiding significance for later research.

Scholars used different methods and indexes to construct the index system for the measurement of food safety regulation. Liu (2009) proposed an evaluation index system for the performance of local food safety regulation. Duan (2014, 2015) et al. used input-output indicators to construct a wide-ranging food safety regulation and evaluation index system of Yunnan Province. Sun (2003) established evaluation system for the comprehensive benefit of food regulation. Wei et al. (2005, 2006) constructed an index system consisting of 39 indexes to evaluate the regulation of the Food regulation Institute of Xuhui District, Shanghai. Subsequently, Wang et al. (2009) proposed that the former model was a multi-level structure model. On the basis of in-depth study of the performance evaluation system of Shenzhen Municipal Government, Lin et al. (2008) established a performance evaluation index system for food regulation and law enforcement, including law enforcement performance, law enforcement efficiency and law enforcement ability. Zhu et al. (2008) conducted a comprehensive evaluation on the capacity building of Beijing's food regulatory system in four aspects, respectively the ability of health administrative licensing, the ability of comprehensive regulation, the ability of case investigation and handling, and the ability to deal with emergencies. By using the Delphi method and focusing on catering businesses, Zhao et al. (2007) screened the index system for food safety protection of major events and conducted an evaluation. From the three dimensions of food quantity safety index, food quality safety index and food sustainable development index, Li (2004) constructed a comprehensive evaluation index system for food safety and evaluated the current situation of food safety in China.

2.3 Research gap

Through literature review, it is found that scholars have different focuses on measuring food safety regulation, but they are not suitable for the practice in food safety. In terms of the index design of food safety regulation effect evaluation system, there is a lack of measuring the main body of food consumption. The main obstacle to further research is the lack of data, and all data is at the macro level. It has become a major issue in the field of food safety research as for how to carry out research under the existing objective conditions and obtain detailed data to scientifically and objectively evaluate the effects of food safety regulation in China. At the same time, the research on the current situation of food safety regulation mostly focuses on evaluation, but ignores the measurement of the effect of provincial-level food safety regulation. Most of the studies fail to design the relevant evaluation index system for the level of food safety regulation. At the same time, although these studies put forward a lot of suggestions for improving the strategy of food safety regulation, there is a lack of measurement of the regulation according to the specific links of food safety. Therefore, this paper starts from the concrete practice of food safety regulation, takes the practice of food safety regulation as the basis, and constructs an evaluation index system for the food safety regulation, so as to provide scientific basis for the future evaluation of regulation level.

3. Behavior Analysis of Stakeholders of Food Safety

Stakeholder theory is a common tool used by people in the performance evaluation of organizations and the impact of policy decisions. A stakeholder is a person who can influence the realization of an organization's goals or who can be influenced by the realization of an organization's goals. In food safety regulation, there are generally three stakeholders: government's

regulatory departments, food producers (including catering institutions) and consumers. These three stakeholders will act differently according to their own preferences. According to the stakeholder theory, all three are beneficiaries of food safety regulation. However, since consumers are the ultimate beneficiaries of food safety regulation, their comprehensive evaluation of the regulation level can be regarded as an objective reflection of the food regulation level. Using the stakeholder theory to analyze and establish the index system for the evaluation of food regulation level can help us to comprehensively consider the factors of various interests. This study will design a scientific and reasonable evaluation system from the perspective of beneficiaries, and consumers will use this evaluation system to comprehensively evaluate the level of food regulation, so as to reflect the improvement that food safety regulation has brought for consumers.

3.1 Behavioral analysis of government's regulatory departments

The level of food safety is related to the interests of the consumers, and the regulation behavior of food safety regulation departments directly affects the level of food safety. After the institutional reform in 2013, the State Food and Drug Administration took overall charge of food regulation, which has changed the previous sub-department regulation and improved the efficiency of the departments. In the whole chain of regulation, the CFDA has sub-bureaus, including those at the provincial, municipal, district and county levels. Due to the differences among departments within the bureau and among regional administrations, the rules and regulations of the bureau will often go out of shape after being decomposed layer by layer. Local governments depend on local tax levels, and food producers in some regions are big tax payers. As a result, there is a close relationship between local governments and enterprises, causing them to leave the public interest behind in pursuit of their own interests. Local governments cooperate with local food and drug administrations, and government departments may form alliances with enterprises without being noticed by higher governments, which will directly affect the regulation work. If there is a food safety accident, local regulators will change the way of cooperation and turn to strict law enforcement. However, as long as the negative effects of food enterprises do not affect the achievements of the government, the government will still maintain a relatively laissez-faire attitude towards food producers. Therefore, for local governments, first of all, they will keep consistent with the instructions of the superior governments, but for the sake of their own political achievements, they may also distort the implementation of the instructions of superior governments, and form alliances with enterprises in pursuit of interests. Therefore, the regulation behavior of the regulation department is a very important index to measure the level of food safety regulation.

3.2 Behavioral analysis of food enterprises

Food enterprises including food production, processing and marketing enterprises. To put it simply, a food business is a profitable economic organization, and its actions are with only one purpose: to make profits. Under the condition of stable market environment and perfect credit system, enterprises will reduce production cost and increase profits through proper ways. For example, enterprises will reduce production costs as far as possible by promoting the research and development of production technology and improving the technical level, improve marketing strategies through the study of consumer psychology, formulate marketing more suitable for the

public taste, and expand the market. Positive externalities will be generated by the enterprises, thus reaching the benign development of the enterprises and the benign development of the whole food market. But either of these two approaches will cost a lot of money and manpower in the early stage. Once the market environment is unstable and the credit system is not perfect, some enterprises will not spend a lot of human and financial resources to carry out research and development, but pursue profits through improper ways of production. They do not produce in accordance with prescribed procedures, abuse additives, reduce production costs, gain price advantages, so as to obtain competitive advantage in the market and seek excessive profits. However, this is only a short-term strategy, in order to seek the long-term development of the enterprise, paying attention to the reputation of the enterprise is also an important way to gain access to the consumer market. In the early stage of enterprise development, it is often a general strategy to establish a good corporate reputation and thus occupy the market. However, when the enterprise develops to a certain scale and has a considerable market share and corporate reputation, if the market system and regulation mode are not perfect and the enterprise credit is lacking, the food production enterprises will resort to all means to obtain higher corporate profits. This will not only be of no benefit to the enterprises themselves, but also produce serious negative effects. For those enterprises that adhere to social ethics, the cost of law-abiding production is too high. Although they can provide consumers with high-quality food, they cannot compete with speculative manufacturers in price. Finally, the law-abiding enterprises will be expelled from the market by those not abiding by the laws, which is a destruction to the entire food market.

Therefore, for enterprises that have begun to take shape, in order to establish a good reputation, they hope to have a relatively complete system of food safety regulation, so as to increase market share, realize large-scale production and improve enterprise competitiveness. In other words, the current food market is in urgent need of a complete and efficient system of food safety regulation, and self-inspection by enterprises is also indispensable. Enterprises need to produce positive externalities through their own legal production so as to promote the development of the food market.

3.3 Behavioral analysis of the consumers

Consumers are the ultimate users of food and the ultimate victims of all food safety issues. The quality of food on the market varies, and due to the nature of the food itself and the information asymmetry, consumers cannot get the food information they need. This has a direct impact on consumers' buying behavior, making it easy for them to buy unqualified food, leading to food safety accidents.

As the side effects of unqualified food have a certain lag, when consumers realize that they have eaten unqualified food, most of them have eaten is for a period of time. And because of the variety of foods consumers eat, it is often difficult for them to identify which foods are causing their discomfort. Sometimes, for illegally produced food, if it does not reach a certain amount of consumption, the side effects generally will not appear. Even if there are symptoms, the symptoms will be relatively mild, and the consumers will not care too much, even if there are strong side effects, most consumers will accept the bad luck and will not make complaints. Consumer awareness of rights protection is insufficient, the channels of rights protection is not clear, there are

few channels of complaint at present, the processing time after the complaint is usually long, the result after the processing is usually nothing. Therefore, even if the consumers' rights are protected, the compensation obtained is very low, and the punishment for the illegal enterprises is very weak.

Therefore, due to the imperfect complaint reporting system, low efficiency, high cost of complaint, and no gains from the complaints, consumers lack of motivation to complain. At the same time, consumers have a weak sense of citizenship. They will not take the initiative to protect their rights, but completely leave the task of food safety regulation to the government. In short, consumers support the government to regulate all aspects of food safety from both psychological and operational perspectives.

4. Measurement Elements of Food Safety Regulation Level

The elements of the measure of food safety regulation level are complex and diverse. According to the analysis of food safety regulation, the measurement of food safety regulation level can be divided into subject and object. The subject part is the situation of the food regulation department, while the object part is the situation of the individuals regulated by the food regulation department, namely the overall food safety level, respectively the organizational basis of food safety regulation, the establishment level of relevant regulatory system, the regulation of production and operation subjects and the handling of safety issues, which are all involved in food safety regulation. Therefore, the main elements of the measure of food safety regulation level are: the organizational basis of regulation, the establishment of regulatory system, the regulation of business entities and the handling of safety issues.

4.1 Organizational basis of regulation

The level of food safety regulatory department is directly related to the level of food safety regulation. A unified food safety regulation agency, a sound food safety regulatory system and a food safety regulation mechanism guarantee the efficient operation of food safety regulation and the effective implementation of food safety regulation measures.

The elements of the regulation level of food regulatory agencies include the establishment of quality regulation agencies. Whether regulatory service institutions implement sound management system, whether the scope of regulation reaches each district or county, whether there are coordination and unity within the institution, and whether the establishment of the institution is reasonable, are organizational guarantees to promote the effective implementation of food safety regulation.

The second element is the organizational performance of regulatory agencies in regulation. According to the regulation of *Food Safety Law*, average personnel size of local agency at the villages and towns (subdistrict) should not be less than 5, Personnel in the quality inspection service should attend no less than 40 hours of training on food safety each year. They should have the qualification of food inspection, professional knowledge and understanding of the links where food safety issues may occur.

What's more, the equipment for quality regulatory service should be complete. The law enforcement equipment and facilities of the regulatory authorities should be equipped in accordance with the standard requirements of Document No. 204 [2014] of the Food and Drug Administration.

The frequency of quality inspection service should be different in different places, and the frequency of regulation of the "four small businesses" such as small workshops and small vendors should be increased. We should pursue the diversity of quality inspection services, increase the participation of professional testing institutions, take advantage of the technical advantages of professional testing institutions to implement self-regulation within food production enterprises, make up for the deficiencies of inspection conducted only by the regulatory departments dispatched by the government, so as to lay a good organizational foundation for food safety regulation.

4.2 Establishment of the regulatory system

The establishment of the food safety regulatory system is the guarantee for the comprehensive implementation of food safety regulation. In the risk management of food regulation, the risk should be controlled to the minimum before the food is put into production, so as to provide perfect institutional guarantee for the regulation of food safety. For example, by establishing a sound food information platform, releasing food information in a timely manner, food-related policies, working trends of food regulation departments, disclosing production behaviors of relevant enterprises, and implementing the information sharing system, efforts can be made to overcome the phenomenon of food information asymmetry brought about by the market economy. At the same time, food information should be made open and transparent to reduce the possibility of unsafe food entering the market, and relevant food information should be provided to consumers as much as possible. Food safety information education should be carried out for consumers to help them make better purchase choices and reduce the occurrence of food safety incidents.

Food regulatory agencies should carry out quantitative classification of catering service units and implement the system of "bright kitchen and bright stove" , so as to increase the scientific level of consumers' choice. Credit files of food enterprises should be established, and the production information of food enterprises should be recorded in detail, so as to promote the establishment of food safety traceability mechanism, so that all food reaching consumers can be traced. Enterprises above designated size should implement standardized food production and scientific management, strictly comply with China's regulations on food production in standard, implement good production standards in management, establish a system of critical control points and standardize food production. In addition, a market access system should be established. China is a big agricultural country, and a large number of agricultural products enter the market through retailers, but they usually do not understand the safety standards of production, which requires the inspection of pesticides and other things before the agricultural products of the retailers enter the market. Therefore, it is necessary to improve the level of risk control, establish the record and summary of risk sampling, monitoring and hidden danger screening, and timely publish food risk information.

4.3 Regulation of production and sales entities

The regulation of production and sales entities is the main work of the entire food safety regulation. That mainly includes the regulation of the relevant production, processing and sales enterprises, catering institutions. The completion of relevant certificates. The food production enterprises should be clear about the safety production regulations, safety responsibility system and food safety standards. The food quality inspection report should be complete. The responsibility

management, incoming inspection, certificate and ticket request, production and operation record and delivery inspection system should be established and strictly implemented. The food production and sales site should be clean and tidy. The facilities and equipment, sanitation conditions should be up to standard. Food additives should be strictly controlled, and the production and sale of illegal additives and fake and low-quality food should be seriously dealt with.

The market should be upgraded and transformed. The wholesale market, farmers' market, agricultural products distribution center and supermarkets within the administrative region should establish and implement the edible agricultural products market permit and access system. The market initiators should examine the licenses of operators who enter the market and establish operators' archives. Special rectification measures should be strengthened for meat, eggs, milk, rice, flour, oil and other household food items. regulation and inspection of pig slaughtering inspection and quarantine should be strengthened, and meat products delivered from factories must have "animal product inspection and quarantine certificate" and "meat quality inspection certificate". The management of four small businesses should be strengthened, quality safety systems should be established for small workshop, small food store, small food and beverage stands and small vendors to regulate relevant certificates and the place of food production. We should attach great importance to the disposal of kitchen waste, establish a system for centralized collection, resource utilization and harmless treatment of kitchen waste, crack down on the illegal production and sale of "gutter oil", and strictly prevent "gutter oil" from returning to tables.

4.4 Handling of safety issues

The handling level of safety issues reflects the direction of food safety regulation. We should increase the punishment of defective food, increase the punishment of dishonest enterprises, guide the social co-governance, and provide a good environmental guarantee for food safety regulation. We should implement the recall system of the defective food, strictly deal with the defective food, increase the punishment for the dishonest enterprises, and regularly publish the list of the dishonest enterprises. We should improve the system of consumer complaint reporting, increase the channels of consumer complaint reporting, improve the handling efficiency of consumer complaint reporting, improve the attention paid to consumer complaint events. We should deal with public opinion incidents correctly, trace to the source of the public opinion incidents, strengthen information disclosure, prevent consumers from unnecessary panic, give play to the role of public opinion correctly, and jointly maintain a good environment of the food market. We should practice social co-governance, promote public participation and common governance. Consumers should give play to citizens' awareness of safeguarding their rights, enhance their awareness of food safety and their ability to protect themselves, correctly use their power, take the initiative to regulate food safety issues around them, and actively report illegal food production. News media should play the role of maintaining social food safety together with food industry associations, jointly realize the cooperative governance of the whole society, and promote the improvement of food safety level.

5. Evaluation System for the Measurement of Food Safety Regulation Level

According to the above analysis, the factors affecting the level of food safety regulation are complex and diverse, so the evaluation index system we construct should be characterized by

hierarchy, complexity and comprehensiveness. Based on the principles of being scientific, objective, simple, accessible, quantitative and qualitative and policy relevant, this paper designs an index system for the measurement and evaluation of food safety regulation level. Based on the principles of being systematic, operable, comparable and orientated, this paper constructs an evaluation system.

5.1 Preliminary establishment of the index system

Food safety regulation is a comprehensive social issue with complex relations with the government and relevant departments, food enterprises, the public and other aspects, which is affected by many factors. Therefore, this paper first clarifies the stakeholders in regulatory process and means adopted by the subject of food safety regulation, as shown in Fig. 1. Secondly, based on the analysis of the current situation of food safety regulation in China, and by referring to the research results in related fields, this paper preliminarily establishes 36 indicators covering four aspects, respectively the organizational basis of regulation, the establishment of regulatory system, the regulation of business entities, and the handling of safety issues.

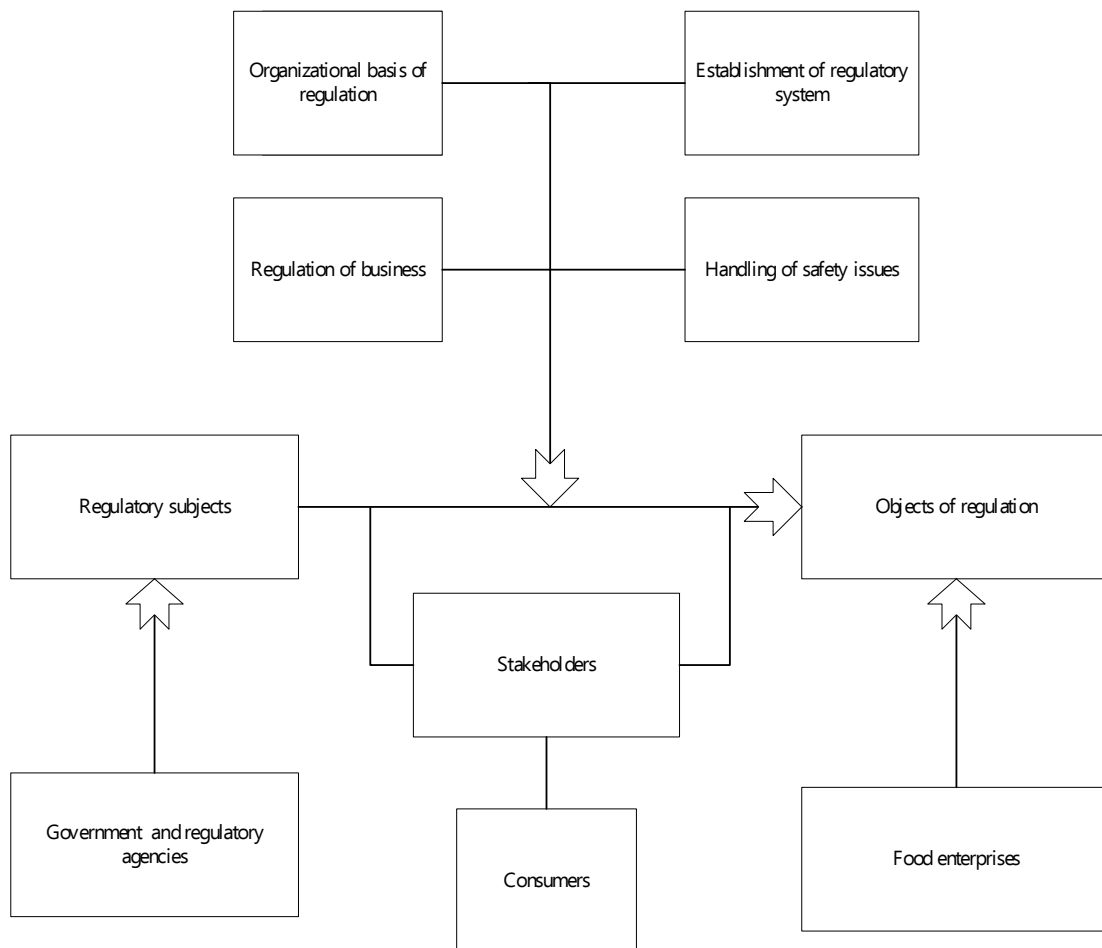


Figure. 1 The relationship of the stakeholders in the food safety regulation

Through the analysis of the subordinate variables of the corresponding first-level index system,

the corresponding index system of food safety regulation level can be constructed.

The second-level indexes under B₁ organizational basis of regulation are: C₁₀₁ level of organization establishment; C₁₀₂ number of service personnel; C₁₀₃ level of economic input; C₁₀₄ quality of regulatory personnel; C₁₀₅ level of technical support; C₁₀₆ level of regulation equipment; C₁₀₇ quality of regulation equipment; C₁₀₈ training of regulatory personnel; C₁₀₉ frequency of regulation; C₁₁₀ mode of regulation.

The second-level indexes under B₂, the establishment of regulatory system are: C₂₀₁ establishment of information platform; C₂₀₂ level of risk control; C₂₀₃ system of enterprise credit; C₂₀₄ food safety tracing mechanism; C₂₀₅ recall system of defective food; C₂₀₆ establishment of market access system; C₂₀₇ rating of catering businesses; C₂₀₈ production control system of enterprises; C₂₀₉ education of food safety knowledge; C₂₁₀ establishment of laws and regulations; C₂₁₁ system of market access and exit permit.

The second-level indexes under B₃, regulation of business entities are: C₃₁ regulation of production and sales individuals; C₃₂ related certificates; C₃₃ compliance with production safety regulations; C₃₄ environment of food production and sales; C₃₅ market upgrading and transformation; C₃₆ use of food additives; C₃₇ level of special rectification; C₃₈ management of four small businesses; C₃₉ disposal of kitchen waste.

The second-level indexes under B₄, handling of safety issues are: C₄₁ handling of dishonest enterprises; C₄₂ handling of defective food; C₄₃ handling of food safety accidents; C₄₄ handling of public opinion incidents; C₄₅ handling of complaints and reporting; C₄₆ level of social co-governance.

5.2 Screening of the index system

5.2.1 Index screening and data collection

The researcher consulted relevant experts and scholars, the State Food and Drug Administration, and food safety regulation staff of a provincial Food and Drug Administration. In this study, 20 questionnaires were sent out and 20 valid questionnaires were collected. The questionnaire adopts the method of subjective valuation, assigning values of 5, 4, 3, 2 and 1 to very important, important, general, unimportant and very unimportant.

5.2.2 Index screening and data analysis

Through the collection of relevant data, the researcher analyzed the data in EXCEL.

5.2.3 Index elimination

The average value of experts' ratings of the importance of each indicator is calculated. According to the statistical results, the average importance of these indicators is lower than 4: C₁₀₃ level of economic input; C₁₀₅ level of technical support; C₁₀₇ quality of regulation equipment; C₁₀₈ training of regulatory personnel; C₂₀₅ recall system of defective food; C₂₁₀ establishment of laws and regulations; C₂₁₁ establishment of agricultural product inspection stations and C₃₁ regulation of production and sales individuals. They are low-impact indexes that can be eliminated. The average value of the remaining indexes is greater than or equal to 4, indicating that the respondents consider these indexes important and they can be taken as formal indexes.

5.3 Final determination of the index system

After eliminating indexes with low influence according to the above analysis, the final evaluation index system is obtained. The model of the index system is as shown below.

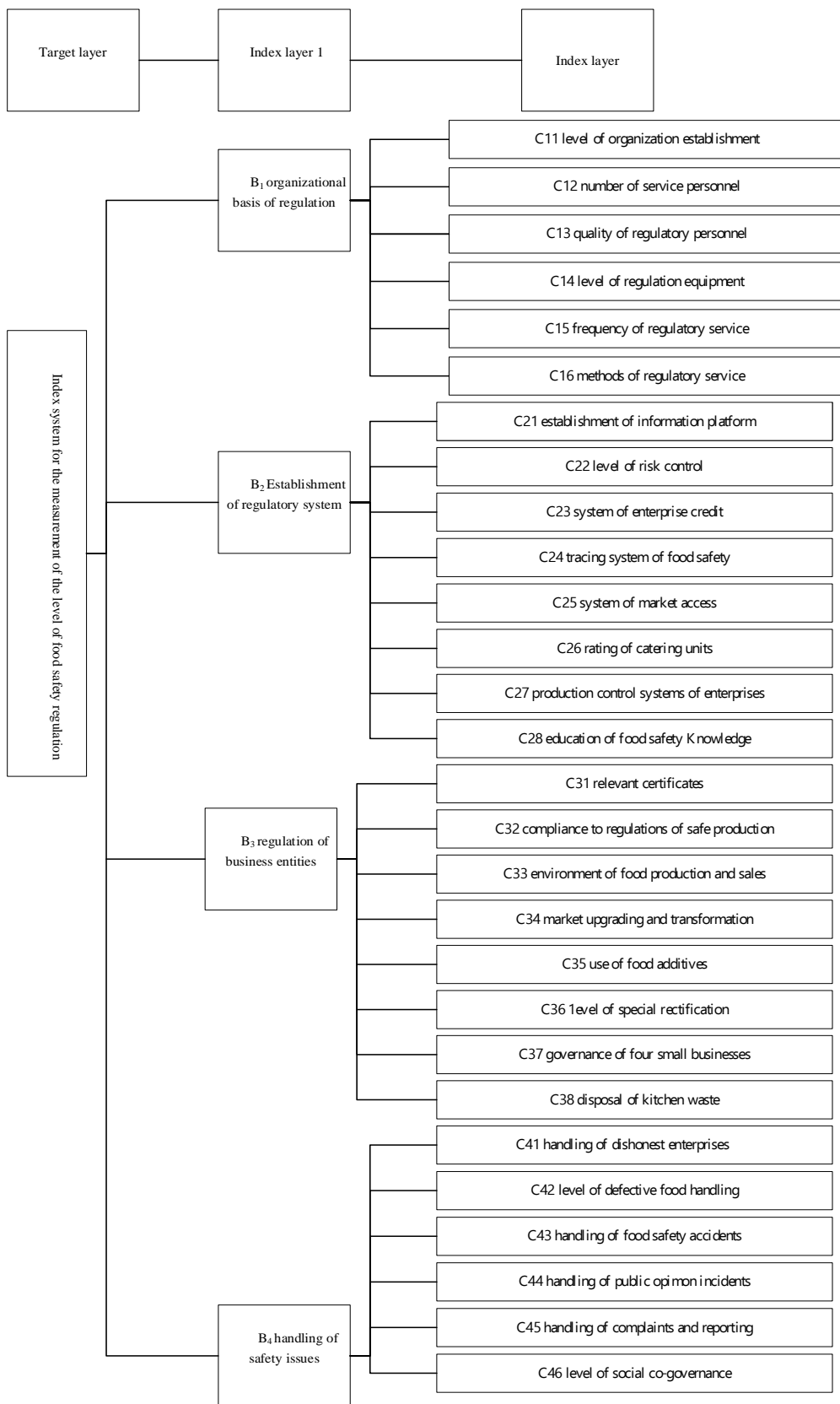


Figure. 2 Index system for the measurement of food regulation level

6. Determining the weights of indexes in the evaluation system

The famous American operational research scientist T.L.Sacty et al. put forward the Analytic Hierarchy Process (AHP) in the 1970s, which is a multi-criterion decision-making method combining quantitative and qualitative analysis. In order to ensure the scientific and rational design of index weight, this paper design index weight in combination with the analytic hierarchy process.

1) Constructing the hierarchy structure model

The structure model of the designed indexes was constructed in Yaaph.

2) Data collection through AHP

By means of expert consultation, I selected 8 government personnel engaged in food safety regulation and related experts and scholars, and gave them a questionnaire on the relative importance of each evaluation index. The relative importance of each index was compared and ranked, and the judgment matrix of each level index was obtained respectively.

3) Weight of first-level indexes

According to the experts' scores on the relevant indicators, the weights of each level index can be ranked through the analytic hierarchy process. According to the index design, the weights of four first-level indexes, namely, the foundation of regulatory organization, the establishment of regulatory system, the regulation of business entities, and the handling of safety issues, should be obtained first. A comparative judgment matrix is made for the scores of the 8 experts, and the data of the 8 experts are averaged by the method of averaging, so as to obtain the weight of the first-level indexes. The weight of each index is calculated by the judgment matrix, and the consistency is tested by the difference between λ_{max} , the theoretical maximum eigenvalue of the judgment matrix and n . The CR of each judgment matrix equals or is lower than 0.1 ($CR \leq 0.1$), indicating that the judgment matrices have passed the consistency test.

In the data analysis, the credit rating of the experts participating in the questionnaire is regarded as the same, and their familiarity with the evaluated content is consistent. The weights of indexes scored by experts in the above table are averaged. The weights of the regulatory organization foundation, the establishment of regulatory system, the regulation of business entities, and the handling of safety issues are respectively:

Table 1 Weights of first-level indexes obtained through AHP

Index	Weight after averaging
Organizational basis of regulation	0.182
Establishment of regulatory system	0.2706
Regulation of business entities	0.3241
Handling of safety issues	0.2233

4) Weights of second-level indexes in the organizational basis of regulation

After comparing the importance of first-level indexes, it is necessary to compare the importance of second-level indexes in the organizational basis of regulation. A comparative judgment matrix is formed for the scores given by the 8 experts, the weight of each index is calculated by the judgment matrix, and the consistency is tested by the difference between λ_{max} , the theoretical maximum

eigenvalue of the judgement matrix and n. The CR of each judgment matrix equals or is lower than 0.1 ($CR \leq 0.1$), indicating that the judgment matrices have passed the consistency test.

The familiarity of the evaluation content is consistent. The index weights obtained by the experts' scores in the above table are averaged, and the weights of the second-level indexes in the organizational basis of regulation are respectively:

Table 2 Weights of the organizational basis of regulation obtained through AHP

Index	Weight after averaging
Level of institutional establishment	0.1761
Number of regulatory personnel	0.1045
Quality of regulatory personnel	0.2587
Level of regulatory equipment	0.1285
Regulation frequency	0.0674
Methods of regulation	0.2649

5) Weights of the establishment of the regulatory system

The same method is used to compare the importance of the second-level indexes in the establishment of the regulatory system, and comparative judgment matrices are made for the scores given by the 8 experts. The weight of each index is calculated by the judgment matrix, and the consistency is tested through the difference between λ_{max} , the theoretical maximum eigenvalue of the judgement matrix and n. The CR of each judgment matrix equals or is lower than 0.1 ($CR \leq 0.1$), indicating that the judgment matrices have passed the consistency test.

In the data analysis, the credit rating of the experts participating in the questionnaire is regarded as the same, and their familiarity with the evaluated content is consistent. The index weights obtained by experts' scores in the above table are averaged, and the weights of the second-level indexes in the organization basis of regulation are as the following:

Table 3 Weights of the establishment of regulatory system obtained through AHP

Index	Weight after averaging
Establishment of information platform	0.1126
Level of risk control	0.1326
System of enterprise credit	0.0726
Food safety tracing mechanism	0.1775
Establishment of agricultural product inspection stations	0.0736
Rating of catering units	0.1128
Production control systems of enterprises	0.2250
Education of food safety knowledge	0.0934

6) Weights of the regulation of business entities

The same method is used to compare the importance of the second-level indexes in the regulation of business entities, and comparative judgment matrices are made for the scores given by

the 8 experts. The weight of each index is calculated by the judgment matrix, and the consistency is tested through the difference between λ_{max} , the theoretical maximum eigenvalue of the judgement matrix and n. The CR of each judgment matrix equals or is lower than 0.1 ($CR \leq 0.1$), indicating that the judgment matrices have passed the consistency test.

In the data analysis, the credit rating of the experts participating in the questionnaire is regarded as the same, and their familiarity with the evaluated content is consistent. The index weights obtained by experts' scores in the above table are averaged, and the weights of second-level indexes under the regulation of business entities are as the following.

Table 4 Weights of the regulation of business entities obtained through AHP

Index	Weight after averaging
Relevant certificates	0.0874
Compliance to regulations of safe production	0.1117
Environment of food production and sales	0.1864
Market upgrading and transformation	0.0455
Use of food additives	0.2113
Level of special rectification	0.1136
Governance of four small businesses	0.1056
Disposal of kitchen waste	0.1382

7) Weights of the handling of safety issues

The same method is used to compare the importance of the second-level indexes in the handling of safety issues, and comparative judgment matrices are made for the scores given by the 8 experts. The weight of each index is calculated by the judgment matrix, and the consistency is tested through the difference between λ_{max} , the theoretical maximum eigenvalue of the judgement matrix and n. The CR of each judgment matrix equals or is lower than 0.1 ($CR \leq 0.1$), indicating that the judgment matrices have passed the consistency test.

In the data analysis, the credit rating of the experts participating in the questionnaire is regarded as the same, and their familiarity with the evaluated content is consistent. The index weights obtained by experts' scores in the above table are averaged, and the weights of second-level indexes in the handling of safety issues are as the following.

Table 5 Weights of the handling of safety issues obtained through AHP

Index	Weight after averaging
Handling of dishonest enterprises	0.1894
Level of defective food handling	0.2348
Handling of food safety accidents	0.0865
Handling of public opinion incidents	0.14935
Handling of complaints and reporting	0.0697
Level of social co-governance	0.2703

8) Overall ranking of the hierarchy

Through data analysis, the weight between each two adjacent index layer is obtained. The weight of index layer B to the target layer is set as WB, that of index layer C to the target layer is set as WC, that of index layer C to the target layer is set as W, then $W=WB*WC$. In this way, the overall ranking of the indexes of food safety regulation level in China is obtained:

Table 6 Index weights obtained through AHP

Index layer B	Weight WB	Index layer C	Weight WC	Weight W
B ₁ organizational basis of regulation	0.1820	C ₁₁ level of institutional establishment	0.1761	0.0321
		C ₁₂ number of service personnel	0.1045	0.0190
		C ₁₃ quality of quality inspection personnel	0.2587	0.0471
		C ₁₄ level of quality inspection equipment	0.1285	0.0234
		C ₁₅ frequency of quality inspection service	0.0674	0.0123
		C ₁₆ method of quality inspection service	0.2649	0.0482
B ₂ establishment of regulatory system	0.2706	C ₂₁ establishment of information platform	0.1126	0.0305
		C ₂₂ level of risk control	0.1326	0.0359
		C ₂₃ system of enterprise credit	0.0726	0.0196
		C ₂₄ tracing system of food safety	0.1775	0.0480
		C ₂₅ establishment of market access	0.0736	0.0199
		C ₂₆ rating of catering units	0.1128	0.0305
		C ₂₇ production control systems of enterprises	0.2250	0.0609
		C ₂₈ education of food safety knowledge	0.0934	0.0253
B ₃ regulation of business entities	0.3241	C ₃₁ relevant certificates of catering points	0.0874	0.0283
		C ₃₂ compliance to regulations of safe production	0.1117	0.0362
		C ₃₃ environment of food production and sales	0.1865	0.0604
		C ₃₄ market upgrading and transformation	0.0455	0.0148
		C ₃₅ use of food additives	0.2114	0.0685
		C ₃₆ level of special rectification	0.1136	0.0368
		C ₃₇ governance of four small businesses	0.1056	0.0342
		C ₃₈ disposal of kitchen waste	0.1383	0.0448
B ₄ handling of safety issues	0.2233	C ₄₁ handling of dishonest enterprises	0.1894	0.0423
		C ₄₂ level of defective food handling	0.2348	0.0524
		C ₄₃ handling of food safety accidents	0.0865	0.0193
		C ₄₄ handling of public opinion incidents	0.1494	0.0333
		C ₄₅ handling of complaints and reporting	0.0697	0.0156
		C ₄₆ level of social co-governance	0.2703	0.0603

7. Conclusions

Economy in China has developed rapidly, but the current situation of food safety has not been effectively improved. As the main subject of food safety regulation, Food and Drug Administration has also undergone a reform, and the role of food safety regulation level in food safety has been increasingly highlighted. Therefore, it is of profound practical significance to study the evaluation system of food safety regulation. This paper analyzes the research results on evaluation of the level of food safety regulation, and designs an evaluation system applicable to the level of food safety regulation. After the initial performance index system is established, the indexes are screened through a questionnaire survey, thus the index system of this paper is constructed. The average scores of the indexes are calculated, indexes with low influences are eliminated. In this way, the evaluation index system thus constructed not only inherit the existing research results, but can also reflect the focus of the regulatory authorities. Through the research of evaluation method, this paper establishes the system of evaluation method, introduces the analytic hierarchy process to determine the weights of each index level in this system, solves the problem of synthesizing the evaluation results of multiple individual evaluators well, and gets reasonable and scientific evaluation results in the practical process of application.

References

- [1] Bai L, Ma C, Gong S (2005). *An Empirical Study on the Implementation of HACCP Food Safety Management System among Chinese Food Enterprises*. *Food Industrial Technologies*, 9: 16-18.
- [2] Clive O, Potter M, Riemann H P (2005). *Foodborne Infections and Intoxications*. 3rd ed. London: Academic Press, 876-877.
- [3] Duan W, Deng X (2014) et al. *establishment of Evaluation Index System of Food Safety regulation Efficiency in Yunnan Province*. *Journal of Kunming University of Science and Technology*, 14: 17-23.
- [4] Duan W, Yang J (2015). *Management System and Operation Mechanism of Food Safety in Yunnan Province*. Wuming: Yunnan Science & Technology Press.
- [5] Golan E.H., Vogel S.J, Frenzen P.D (2001). *Tracing the costs and benefits of improvements in food safety: the case of hazard analysis and critical control point program for meat and poultry*. United States Department of Agriculture, Economic Research Service.
- [6] Halachmi A. (2003). *Government Achievements and Quality Assessment: Problems and Experience*. Guangzhou: Sun Yat-sen University Press, 35.
- [7] Han Y, Chen J, Li C (2011). *Analysis on Vertical Cooperation form and Influencing Factors of Food Traceability System in China -- A Case Study of Vegetable Processing Enterprises*. *China's Rural Economy*, 12: 54-67.
- [8] Henson S.(1997)*Estimating the incidence of food-borne Salmonella and the effectiveness of alternative control measures using the Delphi method*.*International journal of food microbiology*. 35 (3): 195-204.
- [9] Hu Y(2011). *Framework Analysis and Detailed Observation of Food Safety regulation*. *Reform*, 10: 147-154.
- [10] John A (2001). *Chapter 19 Economic analysis of food safety*. *Handbook of Agricultural Economics*, 1: 1083-1136.
- [11] Lei X, Qiu R, Wu Y (2011). *Model of Food Safety Early Warning based on Supply Chain and Extension Decision and Its Application*. *Journal of China's Safety Science*, 11: 136-143.
- [12] Liu C, Zhang H, An Y (2011). *Research on Weak Links, Essential Causes and Critical Control Points of China's Food Quality and Safety -- an Empirical Analysis based on 1460 Food Quality and Safety Incidents*. *Issues of Agricultural Economy*, 1: 24-31

- [13] Liu L, Hou J, Dong Y (2009). *Exploration of Evaluation Methods of Food Safety regulation Performance*. *Journal of Guangxi University (Edition of Philosophy and Social Sciences)*, 4: 52-55.
- [14] Liu P (2010). *Food Safety Regulation in China: an Empirical Study based on Institutional Change and Performance Evaluation*, *Journal of Public Administration*, 2:26-83.
- [15] Liu W, Wei Y, Pan J (2008). *Analysis of Key Factors Influencing the Performance of China's Food Safety Control at the Present Stage -- an Empirical Study based on 9 Provincial (Municipal) Food Safety Demonstration Zones*. *Business Research*, 7: 23-27.
- [16] Liu X, Zheng F, Luo H(2008). *Study on the Cost of Food Safety Regulation Compliance by Enterprises - Based on the Empirical Analysis of HACCP Adoption by Food Enterprises in Beijing*. *Reform of Economic System*, 6:73-78.
- [17] Maronpot R, Davis J (2013), et. al. *Evaluation of 90-day oral rat toxicity studies on the food additive, gum ghatti*. *Food and Chemical Toxicology*, 51:215-224
- [18] Sun S, Li Juan, Zhang J (2011). *Quality Safety Awareness and Behavior Analysis of Pig Farmers in the Quality Pork Supply Chain -- Based on a Questionnaire Survey of 653 Pig Farmers in 9 Provinces*. *Issues of Agricultural Economy*, 3: 76-81.
- [19] Sun T, Li L (2003). *Research on the Evaluation System the Comprehensive Benefit Brought by Health regulation*. *Chinese Public Health*, 9(07):11-12.
- [20] Sylvain C & Chris Y (2008). *Food Safety Performance World Ranking in 2008*, *Resarch Network in Food Systems*, <http://www.ontraceagrifood.com/ad-mincp/uploadfiles/Food%20Safety%20Performance%20World%20Ranking%202008>.
- [21] Sylvain C (2008). *Marketing Agricultural Commodities on Global Markets*. *Journal of International Food & Agribusiness Marketing*, 20 (1): 8-11.
- [22] Wang N, Ren Y (2011). *On the Efficiency of Food Safety regulation*. *Research of Financial Issues*, 12.
- [23] Wang S, Bei W, Xie H (2009) et al. *Discussion on the Framework of Performance Evaluation Index System of Health regulation in Shanghai*. *Modern Preventive Medicines*, 36 (12): 2376-2377.
- [24] Wang Z, Weng Y, Yang Z (2006). *Effectiveness of HACCP Certification Adopted by Food Processing Enterprises: a Survey of 482 Food Enterprises Nationwide*. *China Soft Science*, 9: 69-75.
- [25] Wei C, Chen X (2005), Zhang Kehong et al. *Study on Performance Evaluation Index System of District Health regulation Institutions*. *China's Health regulation*, 12 (05): 340-344.
- [26] Wei C, Chen X (2006), Zhang Kehong et al. *Application of Evaluation Index System of the Performance of District Health regulation Institutions*. *China's Health regulation*, 13 (01): 5-8.
- [27] Ye J (2012). *Research on the Backward Control Performance of Quality Safety Traceability System in Pork Processing Enterprises*. *Issues of Agricultural Economy*, 8: 84-91.
- [28] Zhang Z, Zhang H (2014). *Indirect Effect Evaluation of Food Safety Regulation in China - A Case Study of Dairy Safety Regulation*. *Economic Theories and Economic Management*, 5: 58-68.
- [29] Zhou J (2006). *Analysis of Vegetable Quality and Safety Control Behavior of Farmers and the Influencing Factors*. *China's Rural Economy*, 11: 25-33.