

# Research on the Evaluation of Takeaway Food Quality Supervision Level Based on Analytic Hierarchy Process

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**Abstract**—With the rapid development of takeaway industry, the quality supervision of takeaway products is becoming a research hotspot. Since the quality supervision of takeaway food involves many subjects, it is difficult to evaluate the quality supervision level of takeaway food. According to the influencing factors of the quality supervision of takeaway food, Analytic Hierarchy Process (AHP) is used to evaluate the quality supervision level of takeaway food. AHP decomposes the problems to be studied into multiple factors, combines qualitative analysis and quantitative analysis and maximizes the accuracy of the model. The conclusion shows that among all the influencing factors, the government supervision has the greatest impact, and puts forward the corresponding policy suggestions from the perspective of government supervision.

**Keywords**—Takeaway Food; Quality Supervision; Analytic Hierarchy Process; Evaluate

## 1 INTRODUCTION

In recent years, the quality of takeaway food has repeatedly encountered problems, and the safety of takeaway food is related to the life and health of the people. The quality supervision of takeaway food has become the focus of attention from all walks of life. The quality supervision of takeaway food involves the government, the takeaway platforms and the takeaway food processors. The evaluation of the quality supervision level of takeaway food is complex and changeable. Therefore, the quality supervision level of takeaway food directly affects food safety and people's life and health.

Academic circles have carried out a series of studies on food quality supervision. Zhu and Sun have constructed a tripartite evolutionary game model of food production enterprises, third-party testing institutions and government regulatory departments. The study found that the cost of testing and supervision is an important factor in tripartite decision-making [1]. Xu and Jing built an evolutionary game model between food production enterprises and local governments, and found that the regulatory cost is closely related to the level of local economic development [2]. Zhang and Lai built a game model between catering enterprises and consumers, and between government regulators. The study found that reducing the cost of supervision helps to improve the effectiveness of supervision [3]. Mu and Yang build a game model between consumers and food production enterprises. The relevant results are tested by the empirical model. The research shows that when the cost of consumer complaints is low, increasing the amount of consumer compensation helps to improve the level of food quality and safety risk control [4]. Wan, Qin and Ding established a game model between consumers and food producers, and introduced

consumption substitution parameters. The research shows that when the level of consumption substitution is low, the government must strengthen supervision so that food producers can consciously produce qualified food to the maximum extent [5]. Liu and Fei built a Stackelberg game model to analyze the food quality decisions under two different situations with food manufacturers and retailers as leaders [6]. Zhou and Yang analyzed the information supply of food quality and safety [7]. Zhang established a signaling game model between online food sellers and consumers, analyzed the equilibrium conditions, and found that an effective quality signaling mechanism can distinguish high-quality food from low-quality food [8]. Liu and Liu discussed the network food quality and safety control measures [9]. Fei and Wang analyzed the quality supervision of online food from the game process between online food dealers and producers [10]. Zhang analyzed the "prisoner's paradox" of food quality and safety from the perspective of law, and got relevant policy suggestions [11]. From the perspective of law and economics, Chen studied the enterprise accountability mechanism of food quality traceability supervision, and the research shows that the form of industrial organization is very important for the formulation of enterprise accountability mechanism [12].

To sum up, the existing literature analysis method is mainly based on game theory, but how to evaluate the quality supervision level of takeaway food is relatively rare. The takeaway food market in China is growing rapidly. In particular, the research on the evaluation of the quality supervision level of takeaway food is still in the exploratory stage. Due to the multi subjectivity of the takeaway industry, there are many factors that affect the quality supervision of takeaway food. Therefore, there are relatively many evaluation indicators to be selected. At present, the Analytic Hierarchy Process (AHP) is used for multi index evaluation [13-15], Therefore, this paper attempts to use the Analytic Hierarchy Process to build an evaluation system of takeaway food quality supervision level.

## **2 ANALYSIS ON THE INFLUENCING FACTORS OF TAKEAWAY FOOD QUALITY SUPERVISION**

As the quality supervision of takeaway food involves the government, the takeaway platforms and the takeaway food processors, the influencing factors of the quality supervision of takeaway food mainly include the following factors:

### **2.1 Takeaway food processors**

With the rapid development of takeaway industry, many catering industry practitioners turn to takeaway industry. Takeaway food processors need to strengthen their own supervision to enhance their market competitiveness and maintain food safety.

#### **2.1.1 Food quality supervision system of processors**

At present, many small and medium-sized takeaway food processors have different food quality supervision systems. Although all takeaway food processors have food business licenses, and the takeaway platforms will also sign relevant food quality supervision contracts as a prerequisite for entering the platforms, the system construction of some takeaway food processors is a mere formality. There is no food quality supervision system that meets the requirements for a long time.

### **2.1.2 Self supervision in procurement**

Many upstream manufacturers are involved in the procurement of raw materials for takeaway food. As most takeaway food processors are small and medium-sized, the economic cost is often considered as the limited factor for the source of purchase, so the quality of raw materials is difficult to be guaranteed, and some enterprises have weak self-regulation motivation.

### **2.1.3 Self supervision of production process**

The self-regulation of production process involves the production process of takeaway food. The self-regulation of production process includes the supervision of production environment, the use of additives, the production specification of production personnel and the supervision of production equipment. The production stage is often an important link affecting the quality of takeaway food, so enterprises need to strengthen the self-regulation of production.

### **2.1.4 Self-regulation of finished product preservation process**

Takeaway food is processed into finished products, and the freshness degree of finished products is an important factor for food deterioration. Enterprises should self-regulate the preservation of finished products, focusing on the preservation environment, equipment, preservation technology.

## **2.2 Takeaway platforms**

As the intermediary between takeaway food processors and consumers, there is fierce competition among many takeaway platforms. Some takeaway platforms attract takeaway food processors by lowering the entry threshold of the takeaway industry, which leads to the difficulty in supervising the quality of takeaway food and frequent takeaway food safety incidents. The takeaway platforms need to bear the corresponding social responsibility. It can not only focus on the entry of takeaway food processors, but also need to strengthen supervision.

### **2.2.1 Food quality supervision system of takeaway platforms**

The takeaway platforms need to be responsible for formulating the takeaway food quality supervision system, providing institutional guarantee for the standardized supervision process, adapting the quality supervision system to the national food hygiene regulations, introducing the concept of total quality management, and formulating the supervision system of pre prevention, in-process correction and post correction.

### **2.2.2 Supervision of distribution links**

The takeaway platforms supervise the environment and delivery time of takeaway food delivered by riders to ensure the quality of takeaway food delivery. The distribution link is particularly vulnerable to weather factors, when suffering from extreme weather, it is necessary to strengthen the preservation of food in the distribution link.

### **2.2.3 Supervision of takeaway food processors**

The takeaway platforms need to supervise the food processing industry regularly or irregularly. The takeaway platforms need to deal with the non-conforming food processing industry, cancel

its operation right on the platforms when necessary, and restrict the follow-up operation of the legal representative on the platforms.

#### **2.2.4 Handling of consumer complaints**

The takeaway platforms need to deal with the complaints and reports of consumers in a timely manner and feed back the relevant results. When dealing with the complaints and reports, they need to adhere to the scientificity, objectivity and feasibility. If the situation reflected by consumers is true, the takeaway platforms need to deal with the processors and make reasonable compensation for consumers.

### **2.3 Government departments**

As the takeaway food processors and takeaway platforms are negligent of supervision, government departments need to strengthen the supervision of takeaway food processors and takeaway platforms. Government departments are the last line of defense of takeaway food safety, and need to supervise the quality of takeaway food in an all-round and whole process.

#### **2.3.1 Government supervision system**

Government departments need to supervise the quality of takeaway food processors and takeaway platforms, and establish a set of quality supervision system to ensure that the food quality supervision can have laws to follow and be operable.

#### **2.3.2 Choice of supervision means**

Government departments should pay attention to the choice of regulatory means for food supervision. It is necessary to combine the new technologies such as Internet, big data and block chain to make food traceability, food supervision and so on become feasible.

#### **2.3.3 Supervision of takeaway platforms**

Government departments need to supervise the delivery platform. They can't relax the supervision just because the delivery platform is an intermediary. For the delivery platform that doesn't fulfill the responsibility of supervision, they need to be rectified.

#### **2.3.4 Supervision of takeaway food processors**

Government departments need to strengthen the supervision of food quality of takeaway food processing industry through information technology and on-the-spot investigation to find and deal with problems in time.

#### **2.3.5 Handling of consumer complaints and reports**

Government departments need to check the complaints reported by consumers realistically. If illegal behaviors are found in the takeaway platforms or the takeaway food processors, government departments need to deal with the violators and rectify them. If necessary, they can transfer the illegal clues to the public security organs to investigate their legal responsibilities and ensure the safety of takeaway food.

### 3 THE PRINCIPLE AND STEPS OF ANALYTIC HIERARCHY PROCESS

#### 3.1 The principle of Analytic Hierarchy Process

Analytic Hierarchy Process (AHP) is proposed by Saaty, a professor of operations research. The method decomposes the problems to be studied into multiple factors, and then further divides these factors into target layer, criterion layer and index layer. AHP combines qualitative analysis and quantitative analysis, which can maximize the accuracy of the model and the use method is relatively applicable, and can be applied to complex and changeable situations.

#### 3.2 The steps of using Analytic Hierarchy Process

##### 3.2.1 Building hierarchical structure model

According to the actual situation and the requirements of Analytic Hierarchy Process, it can be divided into target layer, criterion layer and scheme layer.

- a) Target layer: it is to evaluate the level of quality supervision of takeaway food.
- b) Criterion layer: target layer is further divided into three parts: the takeaway food processor, the takeaway platform and the government department.
- c) Programme layer: criterion layer is subdivided into several influencing factors.

The hierarchical structure model of the evaluation index system of takeaway food quality supervision level is shown in Table 1.

**TABLE 1** EVALUATION INDEX SYSTEM OF QUALITY SUPERVISION LEVEL OF TAKEAWAY FOOD

Evaluation index system of takeaway food quality supervision level A	Takeaway food processor B1	Food quality supervision system of processors C1
		Self supervision in purchasing process C2
		Self regulation of production process C3
		Self regulation of finished product preservation C4
	Takeaway platform B2	Food quality supervision system of takeaway platform C5
		Distribution supervision C6
		Supervision of takeaway food processors C7
		Handling of consumer complaints C8
	Government department B3	Government supervision system C9
		The choice of supervision means C10
		Supervision of takeaway platform C11
		Supervision of takeaway food processors C12
		Handling of consumer complaints and reports C13

### 3.2.2 Construction of judgment matrix

Two judgment matrices were constructed according to the expert ratings, and pairwise comparisons of relevant elements were made to score the expert ratings. The 1-9 scale method was adopted, as shown in Table 2 for details. Table 3 is the judgment matrix of the target layer and the criterion layer; Table 4, 5 and 6 are the judgment matrix of the criterion layer and the programme layer.

**TABLE 2** SCALE METHOD 1-9

Scale	Instructions
1	Both elements are of equal importance
3	The former is slightly more important than the latter
5	Compared with the two elements, the former is obviously more important than the latter
7	Compared with the two elements, the former is more important than the latter
9	Of the two elements, the former is extremely important than the latter
2,4,6,8	The importance of the former element over the latter is between the scales
Reciprocal	The latter is more important than the former

**TABLE 3** JUDGMENT MATRIX A-B OF TARGET LAYER AND CRITERION LAYER

A	B1	B2	B3	Wi	$\lambda_{\max}=3.094$ CI=0.047 RI=0.580 CR=0.081
B1	1	2	1/5	0.19	
B2	1/2	1	1/4	0.12	
B3	5	4	1	0.69	

**TABLE 4** JUDGMENT MATRIX B1-C OF CRITERION LAYER AND PROGRAMME LAYER

B1	C1	C2	C3	C4	Wi	$\lambda_{\max}= 4.183$ CI= 0.061 RI=0.900 CR= 0.068
C1	1	1/3	1/3	1/2	0.10	
C2	3	1	1	3	0.36	
C3	3	1	1	6	0.42	

**TABLE 5** JUDGMENT MATRIX B2-C OF CRITERION LAYER AND PROGRAMME LAYER

B2	C5	C6	C7	C8	Wi	$\lambda_{\max}=4.202$ CI= 0.067 RI=0.900 CR= 0.075
C5	1	1/4	1/7	1/6	0.06	
C6	4	1	1/2	2	0.29	
C7	7	2	1	1	0.39	

**TABLE 6** JUDGMENT MATRIX B3-C OF CRITERION LAYER AND PROGRAMME LAYER

B3	C9	C10	C11	C12	C13	Wi	$\lambda_{\max}= 5.055$ CI= 0.014 RI=1.120 CR= 0.012
C9	1	1/2	1/3	1/4	1/3	0.07	
C10	2	1	1/2	1/2	1/2	0.14	
C11	3	2	1	1/2	1	0.22	
C12	4	2	2	1	1	0.31	
C13	3	2	1	1	1	0.26	

### 3.2.3 Hierarchical single sort and its consistency test

Hierarchical single ranking is a process of calculating the eigenvalues and eigenvectors of judgment matrix, and calculating the corresponding weights. This paper uses the square root method to calculate the eigenvalues. Taking the calculation of judgment matrix A-B as an example, the calculation steps are as follows:

a) Calculate the product of each element in each row of the matrix:

$$E_{ij} = \prod_{j=1}^n b_{ij} \quad (1)$$

b) Calculate the n-th root  $E_i$  of  $E_{ij}$ :

$$E_i = \sqrt[n]{E_{ij}} \quad (2)$$

c) After normalizing the vector  $W_i$ , the feature vector is obtained:

$$W_i = E_i / \sum_{i=1}^n E_i \quad (3)$$

d) Calculate the eigenvalue of the eigenvector:

$$\lambda_{\max} = \sum_{i=1}^n (BW)_i / nW_i \quad (4)$$

e) Calculate the consistency index CI,  $CI = (\lambda_{\max} - N) / (n - 1)$ , the random consistency index RI proposed by Saaty is introduced, as shown in Table 7

TABLE 7 CALCULATION OF RI

N	1	2	3	4	5	6	7	8	9
RI	0	0	0.58	0.90	1.12	1.24	1.32	1.41	1.45

When  $CR = CI / RI \leq 0.10$ , the judgment matrix has satisfactory consistency, otherwise it needs to be readjusted.

Through calculation, the CR of A-B judgment matrix can be obtained, which is less than 0.10, indicating that the A-B judgment matrix has passed the consistency test, as shown in Table 3. Similarly, CR of other judgment matrices can be calculated, and CR is less than 0.10, which indicates that other judgment matrices pass the consistency test, as shown in Table 4-6.

### 3.2.4 Hierarchical total ranking and consistency test

According to the result of single level sorting, the result of total level sorting can be obtained, as shown in Table 8.

**TABLE 8** HIERARCHY TOTAL SORTING

Factor	B1 0.19	B2 0.12	B3 0.69	Weight
C1	0.10			0.02
C2	0.36			0.07
C3	0.42			0.08
C4	0.12			0.02
C5		0.06		0.01
C6		0.29		0.03
C7		0.39		0.05
C8		0.26		0.03
C9			0.07	0.05
C10			0.14	0.10
C11			0.22	0.15
C12			0.31	0.21
C13			0.26	0.18

The consistency test process of hierarchical total ordering is as follows:

Through calculation,  $CI=0.029$ ,  $RI=1.05$ ,  $CR=CI/RI=0.028<0.1$ ,  $CR$  passes the consistency test.

As can be seen from Table 8, among all the influencing factors, the regulatory factor of government departments is the largest. Therefore, government departments need to strengthen the supervision of food processors and takeaway platforms for foreign sales. This paper proposes relevant policy suggestions from the perspective of government departments.

## **4 POLICY SUGGESTIONS ON QUALITY SUPERVISION OF TAKEAWAY FOOD**

### **4.1 Improve the quality supervision mechanism of takeaway food**

At present, the takeaway industry is developing rapidly, and the takeaway food quality supervision mechanism has not been fully established. Therefore, the government departments should improve the takeaway food quality supervision mechanism, so that the takeaway food quality supervision can be in accordance with the law.

### **4.2 Government departments need to establish a collaborative law enforcement mechanism**

As the supervision of takeaway food involves many government departments, such as health, market supervision and management, urban management and so on, it is necessary for different government departments to cooperate in law enforcement, and establish a cross department cooperative law enforcement mechanism, so that takeaway food is completely within the scope of government law enforcement. Different government departments should not let the quality of takeaway food become nobody's business because of different responsibilities.

### **4.3 Normalize the supervision of takeaway industry by means of Online + offline**

For example, government departments can require takeaway food processors to set up video monitoring equipment for food production and preservation, monitor food production and preservation in real time, and store the monitoring video for at least 7 days. Government



departments can also use big data, video monitoring and video monitoring Emerging technologies such as the Internet of things and blockchain can prevent bad food industry practitioners from entering the food industry again by means of changing their identities, and apply emerging technologies to do a good job in food traceability and raw material procurement. However, in addition to online supervision, government departments also need to realize normalized offline on-site supervision, so as to achieve full coverage of takeaway food quality supervision.

#### **4.4 Strengthen the sense of quality responsibility of prevention oriented enterprises**

Both the takeaway food processors and the takeaway platforms are practitioners in the takeaway industry. They need to strengthen the awareness of enterprise quality responsibility. Government departments need to make the takeaway food processors and the takeaway platforms realize that they are the first person responsible for food quality through publicity and guidance, and also need to let enterprises establish a prevention oriented enterprise quality responsibility consciousness, let enterprises consciously implement the food safety responsibility consciousness in food procurement, processing, preservation, circulation and other links, so as to prevent in advance. Adhere to the "zero tolerance" of takeaway food practitioners, and build a blacklist system of food industry practitioners.

#### **4.5 Real time handling of consumer complaints**

When government departments receive consumers' complaints about takeaway food, they need to pay attention to consumers' legitimate demands and conduct on-the-spot inspection on relevant takeaway enterprises to verify the relevant situation. And government departments can receive consumers' complaints and reports in real time through the network platforms, and feed back the complaints and reports of takeaway food through the network platforms in real time, so that it is no longer difficult for consumers to safeguard their rights.

#### **4.6 Reverse the supervision situation of substituting punishment for management and establish a positive incentive mechanism**

In daily supervision, some local government departments are often keen to impose fines on their behalf. For some takeaway food processors and takeaway platforms that need to be shut down, they often only impose fines, and take fines as the only means to deal with them. The person in charge of these enterprises that should have been shut down also continue to work in violation of laws and regulations with the mentality of "if they have been punished, they will be fine.", This will do great harm to the healthy development of consumers' rights and the takeaway industry. In the end, the takeaway industry will see "bad money driving out good money", which will eventually lead to frequent takeaway food safety incidents. Therefore, in order to avoid this situation, government departments need to clarify the purpose of supervision. Supervision is to make the takeaway industry develop healthily and healthily, let consumers buy legal and compliant takeaway food, and also play a role in safeguarding the legitimate rights and interests of enterprises. Fine is only one of many ways, but it is not the only way, All enterprises that need to be shut down will be shut down, and all responsible persons who are banned for life will be banned for life, so as to completely reverse the regulatory situation of punishment instead of management.

In addition to punishment, government departments need to strengthen the construction of positive incentive mechanism. Government departments will give greater rewards to individuals or organizations reporting takeaway food incidents, promote consumers and relevant insiders to report illegal takeaway food processors and takeaway platforms, and when consumers file public interest lawsuits, government departments can give guidance and assistance. The government departments can reward the takeaway food practitioners who have "zero error" in safe production for many years, positively encourage the takeaway food practitioners to set up the model of safe production of takeaway food to the maximum extent, play its exemplary role, set an example for other takeaway food practitioners, and encourage the takeaway food practitioners to operate legally.

## 5 CONCLUSION

The quality supervision level of takeaway food involves many subjects, such as takeaway food processors, takeaway platforms and government departments. Based on the Analytic Hierarchy Process, this paper constructs an evaluation index system composed of 13 programme layer indicators and 3 criterion layer indicators, which can effectively evaluate the quality supervision level of takeaway food and provide decision support for enterprises and government departments. As it is a systematic project to evaluate the quality supervision level of takeaway food, the selection of evaluation indicators is also in constant development, so it is necessary to adjust the evaluation indicators dynamically in time according to the actual development of the takeaway industry to meet the needs of development. The future research direction is to optimize the evaluation process of takeaway food quality supervision level through big data technology.

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