



Study on Evaluation Index Model and Hierarchical Management of Food Safety

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1. Introduction

- While attaching great importance to the enhancement of food safety, the Chinese government has established a supervision and management system of food safety and keeps improving it. In the first half of 2008, a study conducted by the national quality examination & supervision agency indicated that food produced in China passed the safety standards was 98.4%.
- With the fast growth of economy, uncertainties of food safety are also increasing. The emergence of new toxic materials and the advancement of food technologies have brought a number of new problems of food safety, such as the poly-Sudan, melamine and the powdered milk contamination incidents, which caused greater harm to the health of consumers.
- At present, we need a scientific measurement and evaluation system for food safety.



In recent years, food safety problems have drawn intensive attentions of related government departments and scholars world wide.



- Pesticide registration will be based upon aggregate risk to the most susceptible consumers from all pesticides sharing a common biochemical mode of action in humans, rather than a single type of pesticide residue in a single food (FQPA 1996) .
- We should strengthen the control of food safety from farm to fork and gradually set up a traceable system of food production (EU Council 2001).
- Insufficient regulations of government, immoral behaviors of some food products providers and the uncertainty of new technologies are major causes of food safety problems (Zhou Yingheng, Huo Liyue 2003) .
- Chemical fertilizers, pesticides, feed additives, etc. bring risks to food safety (Zhang Lei 2007) ;
- An evaluation model has been set up to make a comprehensive assessment of food Safety in China from the aspects of food quantity security, food safety and food sustainable safety, which includes three-levels and sixteen indexes (Li Zhemin 2004).

2.Characteristics of Food Safety

Food Safety is an integrated concept, which comprises both quality factors, namely the extent to which it meets people's needs, and safety factors, the extent to which it may do harm to people's health.

- Hidden hazards. When the raw material is contaminated, it is difficult to evaluate the food safety situation promptly and accurately.
- Direct hazards. Some food, such as milk powder, can be served directly without cooking.
- Additive hazards. The influence of unsafe factors will pass on to the following steps of the food production chain, and the biochemical reaction will also go on in this way.
- Wide range hazards. Food is produced continuously in large amount with short producing cycle, and reaches large quantity of consumers.

3. Quantitative Evaluation Model for Food Safety

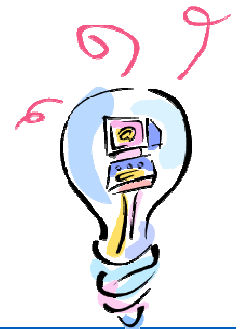
3.1 Evaluation System of Food Safety

Three kinds of requirements relating to food production and sales are as below:

- Market access requirements of food safety, which is the most fundamental requirement in China for food production and sales;
- Supervision and inspection requirements of food safety, which is carried out in a regular or irregular manner by the government in accordance with related technical standards;
- The requirements of HACCP, ISO9001, ISO22000 etc., which fully reflects the food safety control in all production processes of the food production chain.



Figure 1 Requirements on Food Safety



Imperative Requirements

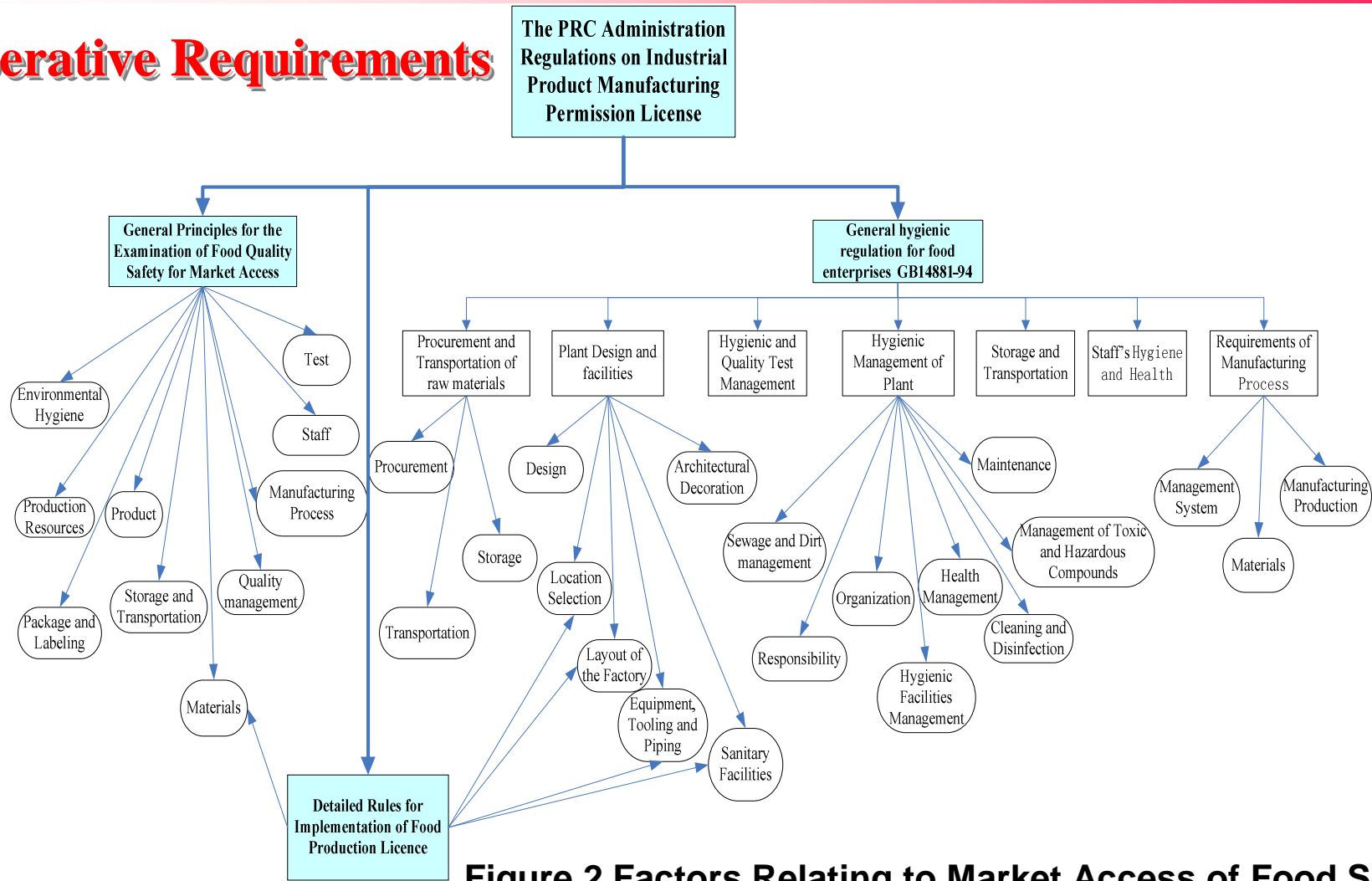


Figure 2 Factors Relating to Market Access of Food Safety

China General Administration of Quality Supervision, Inspection and Quarantine started to implement the market access system of food Safety in July 2002, which was based upon the Administration Regulations on Industrial Product Manufacturing Licenses, the Product Quality Law, the Food Hygiene Law of China, etc.



.General Requirements

It is an effective and major mean of supervision and macro management of product quality by the Chinese government. The criterion of the inspection is based upon related technical standards.

.Incentive Requirements

Enterprises implement ISO9001,HACCP,ISO22000 management systems to improve the management of food production and enhance food safety.

Evaluation index framework of food safety

From the perspective of food production chain, we've analyzed the above requirements and worked out an evaluation index framework for food safety in which the weight of indices is decided with combination of AHP method and evaluation by experts.



The first level indices	The second level indices	Weight	The third level indices	Weight
Evaluation indices for food Safety	Enterprise design and implementation	0.12	1 layout of the factory	0.22
			2 equipment, tooling and piping	0.23
			3 architectural decoration	0.27
			4 sanitary facilities	0.26
	Food enterprise management requirements	0.30	5 organizational leadership	0.18
			6 management goal and objectives	0.16
			7 management responsibility	0.17
			8 production equipment	0.08
			9 staff requirements	0.13
			10 technical standards	0.10
			11 process documents	0.09
			12 document management	0.09
	Control of food hygiene and quality	0.58	13 procurement systems	0.08
			14 procurement inspection	0.13
			15 process management	0.13
			16 quality control	0.11
			17 product protection	0.07
			18 testing equipment	0.07
			19 test management	0.10
			20 process inspection	0.11
			21 normative use of food additives	0.10
			22 recent 3 years' records of sample passing rate	0.10

According to the opinion above, we may build the food Safety model: \leftarrow

$$\text{Food Safety index} = \frac{Y_i}{1+Q_i} \quad (1)\leftarrow$$

While Y_i denotes to the score of i-th food product, which ranges from 0 to 100; \leftarrow

Q_i denotes to the ratio of certain i-th food product sales to the total sales of similar products. \leftarrow

$$Y_i = w_{i1} \sum_{m=1}^7 w_{im} y_{im} + w_{i2} \sum_{m=5}^{12} w_{im} y_{im} + w_{i3} \sum_{m=13}^{22} w_{im} y_{im} \quad (2)\leftarrow$$

w_{ik} denotes to the weight of 2nd level index of i-th food product, $k = 1, \dots, 4$;

w_{im} denotes to the weight of 3rd level index, $m = 1, \dots, 22$. \leftarrow

y_{im} denotes to the score of m-th 3rd level index of i-th food product, so \leftarrow

Generally speaking, one enterprise will produce two or more kinds of food. Here is the food Safety index for enterprises with multiple (L) products: \leftarrow

$$\text{Enterprise's food production Safety index} = \frac{\sum_{j=1}^L Y_j \frac{P_j}{\sum_{j=1}^L P_j}}{\sum_{j=1}^L P_j} \quad (3)\leftarrow$$

P_j denotes to the proportion of j-th food product sale to the total sale of all food of this enterprise. \leftarrow

3.2 Food Safety Index Model

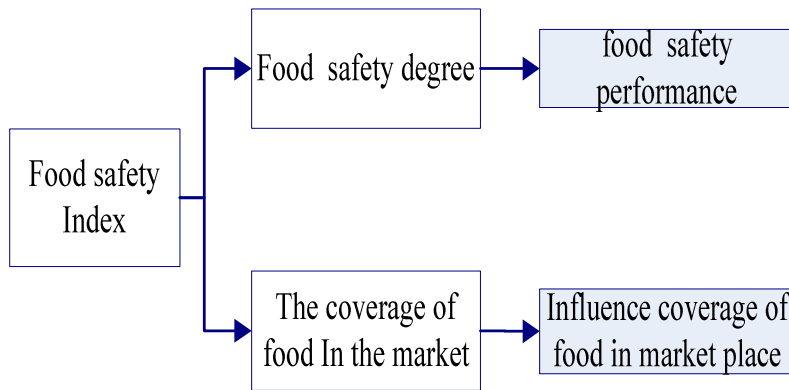


Figure 3 Framework of Food Safety Index Model

4. Hierarchical Management of Food Safety Based on Quantitative Evaluation

By measuring food Safety index, we can define the risk level of food enterprises, on the basis of which we may carry out categorized inspection and supervision in food manufacturers in order to monitor food Safety.

Table 4 Relationship among Food Safety Index, Food Enterprise Level and Risk Level

Food safety index	Food enterprise level	Risk level	Frequency of tour inspection
[100, 85]	A	low ↓ high	Once per year
(85, 70]	B		Twice per year
<70	C		Three times per year

Inspection Results of 2000 Food Manufacturers in Shanghai

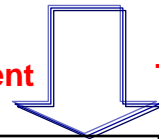


Table 5 Food Enterprises in Hierarchical Management

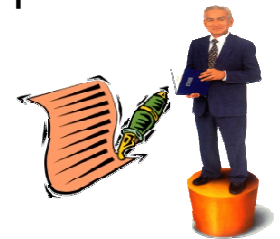
Enterprise level	Number by percentage in 2007(%)	Number by percentage in first half year of 2008(%)
A	21.1	21.1
B	59.0	60.8
C	19.9	18.1

Table 6 Result of Tour Inspection among Food Enterprises of Different Levels

Enterprise level	Average passing rate in 2007(%)	Average passing rate in the first half year of 2008(%)
A	94.7	96.0
B	90.1	92.0
C	87.5	88.4
Total	89.8	91.5

5. Conclusion

- The food safety index model proposed in this paper can well reflect the condition of food safety control in enterprises and provide guidance for food safety supervisor and enterprises to better guarantee food safety.
- By the application of the quantitative evaluation model and hierarchical management method, we can timely identify high-risk food production industries, regions and enterprises, find out risk factors and the weak links of food safety, strengthen the management of critical control process, prevent and control food safety risks.
- It can help food enterprises grasp the condition of food safety and discover the risks and hidden danger in time, thus early warning can be set. It can also encourage food enterprises to reach advanced standards, promote self-discipline, and improve food safety assurance.



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