Safety Management of Food Manufacturing Enterprises Based on MSCA Method

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Abstract: In order to improve the safety management ability of food enterprises, according to the operation and management characteristics of food enterprises in China, the food safety management system is divided into five indicators: personnel, machinery, materials, methods and environment from the perspective of system theory. The safety judgment levels of five indicators are quantitatively analyzed by MSCA method, and the weighted average method is used. Estimate the overall safety level of food safety management system, study a food enterprise based on this safety management model, and draw the corresponding conclusions, and implement the corresponding safety management measures in the follow-up, the results show that this research method is effective.

1. Introduction

With China becoming the second largest economy, the number of food enterprises has increased dramatically, accompanied by an increase in safety incidents. Personnel, equipment, facilities, raw materials, resources and geographical environment in the production system will have an impact on the security of the system [1]. From the point of view of enterprise operation, the safety accidents of food enterprises will also be affected by the above.

Safety management is to carry out activities related to decision-making, planning, organization and control for the purpose of safety [2]. Accident control is the core. Accident prevention is to eliminate potential safety hazards and control unsafe behavior through the combination of management and technology to ensure the safety of workers and workers. There are two kinds of hidden risks: exposure and concealment [3]. Exposure risk is relatively easy to control and hidden risk is easily ignored. MSCA method can effectively eliminate potential and exposure risks. MSCA is abbreviation of the Method of Safety Checklist Analysis，which is based on the relevant standards and specifications of a system, discriminates and inspects the known hazard categories, design defects and potential hazards and harmfulness related to general process equipment, operation and management in engineering and system. This paper mainly establishes a food safety management evaluation model based on MSCA analysis method, and applies the model to the safety management evaluation of a food enterprise, and proves that the evaluation model can improve the safety management level of food enterprises.

2. Current Situation of Food Safety Management Evaluation

The development of food industry has been accompanied by the survival of mankind. As the only country without fault in world history and culture, ancient China has unique knowledge and control of food safety. Safety production of food enterprises is a major event related to the sustainable development of people's lives and property. In the final analysis, food service enterprises are an industry based on safety production, and safety management evaluation of food service enterprises is developing vigorously.

For example, Lu Xiaolian, Jia Jianhui, Wang Xiong and others put forward the urgency and related research of implementing HACCP from the perspective of food safety control [4].Liu Xia, Zheng Fengtian, Luo Hongqi and others used the empirical analysis of HACCP to study the cost of enterprises'compliance with food safety regulations [5].Zhu Jinwei, Li Bingxin and others used empirical analysis to study the influencing factors of social responsibility information disclosure of food enterprises [6].Xu Qing and others made a research on the market safety of brand image maintenance in food safety accidents. [7].Zhang Wanbin studied the application of food safety management system in aviation catering industry [8].

The above research analyzed the control of food production safety and market operation risk from different angles. This paper put forward different methods of safety management evaluation of food enterprises, focusing on the safety management level of food enterprises from the perspective of internal safety management.

3. Evaluation Model of Food Safety Management Based on MSCA

According to the analysis of the operation characteristics of food enterprises, the basic research steps are set: firstly, the comprehensive and systematic safety analysis method is used to decompose the safety management system of food enterprises into five components: personnel, machinery, materials, methods and environment; secondly, the weight coefficient determination method such as expert scoring method is used to evaluate each component. The weight coefficient of the index; the MSCA method is used to establish the safety evaluation grade of each index again; finally, the weighted average method is used to determine the overall data safety grade of the food enterprise safety management system. As human, machine, material, law and environmental management technology are mostly used in industrial production and manufacturing industry, food enterprises need to adjust the relevant elements. For example, the relationship between the mildew of raw materials and weather changes, the time control of human operation of machines and the safety of operators themselves, the human cause is the main cause of accidents [9], which can increase the weight of the proportion of people.

3.1.Analysis of Food Enterprise Safety Management System

According to statistics, the occurrence probability and severity of production accidents are closely related to the five indicators of man-machine data method ring of enterprise production safety management system.

Personnel analysis in the safety management system of food enterprises includes all relevant personnel such as managers, technicians, team leaders, operators, etc. to understand safety management, technical proficiency, physical fitness and other aspects of organizational safety management. Attention should be paid to the improvement of people's quality. About 90% of safety accidents are caused by people's unsafe behavior [9], especially food service enterprises. Food enterprise machinery refers to the equipment, tools and other production machinery used in production. Material generally refers to materials, semi-finished products, accessories, raw

materials and other products. Law is the rules and regulations to be followed in the production process. Specific process instructions, standard processes, production drawings, schedules, operation standards, inspection standards, various operating procedures. The ring finger organization shall determine and manage the working environment required to meet product requirements (ISO 9001:20006.4). Accordingly, the safety management system of food enterprises can be divided into five indicators: personnel, machinery, materials, methods and environment.

3.2. Method for Determining Weight Coefficient of Safety Management Index in Food Enterprises

In the multi-factor comprehensive analysis model, the determination of index weight coefficient is the key to quantitative evaluation. Safety management evaluation of food enterprises should be based on the actual situation of safety management system of enterprises in different industries and reasonably select the weight coefficient of evaluation index to determine the method. The determination of weight coefficients can be obtained by cluster analysis of experts based on the principle of fuzzy clustering analysis [10]. For food enterprises, most of the time, the weight coefficient is determined by the method of ranking and scoring according to the statistical results by experts, but the emphasis is different. Experts from food industry enterprises with more than 20 years'experience are invited to determine industry indicators based on safety accident data analysis in recent 10 years. But the weights of different industries are different. For example, tourism enterprises should pay attention to the safety of traffic buses, outdoor exploration should pay attention to the change of weather (debris flow, earthquake, mountain torrents, etc.), while food enterprises should pay special attention to the safety of people's operation and materials. This paper mainly adopts accident statistics and expert analysis.

3.3. Classification and Determination of Safety Grade of Safety Management System in Food Enterprises

In this paper, MSCA method is used to classify and determine the safety grade of safety management system and indicators in food enterprises. Firstly, the safety grade classification standard of food enterprise safety management system and index is stipulated. The classification standard is shown in Table 1. Then, MSCA method is used to inspect each index of safety management in food enterprises. According to the results of the checklist, the safety evaluation criteria of the corresponding management index are obtained. Finally, the safety grade of the index is determined according to the safety grade classification criteria. Assuming that the safety evaluation score of the first index obtained by the safety checklist is Mi (Mark), according to Table 1, the corresponding security level is Gi (Grade).

Table 1: Security level score level.

Scoring range	Safety grad	Explanatory notes	Safety grade
0＜M＜30	I	Highly dangerous, extremely low level, need to take immediate safety management measures	G1
30 ≤M＜60	II	The danger level is very low and measures must be taken	G2
60 ≤M＜80	III	Critical safety level; low level, measures should be taken	G3
80 ≤M＜90	IV	Safety level, medium, can take measures to further improve the level of security	G4
90 ≤M≤100	V	Super security level, higher level, should maintain the existing level of security	G5

According to the above method, the weight coefficients and quantity safety checklist of food enterprise safety management indexes are obtained, and the safety evaluation scores of each index are obtained. The overall safety evaluation scores of enterprise safety management system are obtained by weighted average method. Assuming that the overall safety score of the safety management system of production enterprises is M, there are:

$$M = \sum_{i=1}^{n} R_i M_i$$

(1)

In formula (1), n is the number of enterprise safety management indicators; Ri represents the weight coefficient of enterprise safety management indicators, and R (Ratio) satisfies the conditions:

$$\sum_{i=1}^{n} R_i = 1$$

(2)

Then according to Table 1, the overall security level of the enterprise safety management system is M. The strength, time and quantity of safety management measures are different according to different grades. If the safety level of the enterprise safety management system obtained by the safety management evaluation is less than 60 points, it shows that the enterprise safety management is weak and the probability of accidents is high. It is necessary to stop production immediately for inspection and implement effective measures to continue operation. If it is in the fourth level, it should be paid great attention to quickly, and it can be operated while rectifying. Where there are potential safety hazards, if safety management measures are not taken in time, there will be the possibility of an outbreak.

4. Application of MSCA Method in Food Enterprises

This paper applies the method-based safety management evaluation model to the safety management evaluation of a food enterprise. Because of the sensitivity of data and the external market influence of enterprise operation, the name of the food enterprise is hidden. The methods are as follows: Firstly, the safety management system of food enterprises is scientifically divided into five measurement indicators: human-material method ring, accident statistics method and Delphi method to establish the weight coefficients of each index. Secondly, the MSCA method is used to calculate the result score of each index's safety checklist and get the safety evaluation score of each index. According to the safety management system of food enterprises and the safety classification table of the index, the safety grade score of the index is determined. Thirdly, according to the safety evaluation scores of each index and the corresponding weight coefficients of food enterprises, the

overall safety level of the food enterprises in this study was obtained by weighted average method. In this way, the direct and indirect hazard risk of the food enterprise can be measured comprehensively.

4.1. The Weight Coefficient of Safety Management Index of Food Enterprises is Determined

According to the actual situation of safety management evaluation of food enterprises, the appropriate weight determination method is selected. For food enterprises, the weight coefficients of each risk factor can be obtained by accident statistics. According to the analysis and statistics of 100 cases of food safety accidents by Shanghai Xilang Investment Management Co., Ltd., the human factor is the main factor and the material factor is the secondary factor, so effective human resource management will bring positive organizational output [11].

Table 2: Determination of weight coefficient of food safety quality elements.

	1	2	3	4	5	6	7	8	9	10	Weight
Personnel	40	38	45	32	30	42	25	28	24	50	35.4
Machinery	20	21	10	20	22	23	25	20	18	10	18.9
Materials	13	15	20	20	23	20	25	22	22	20	20.2
Method	17	15	10	15	13	7	10	10	20	10	13.2
Environment	10	9	15	13	12	8	15	15	16	10	12.3

Food safety experts with more than 20 years scoring statistics of weight factors, 10 food safety management experts scoring statistics of the five factors of man-machine material law ring, the total score of the five factors is controlled at 100, according to the calculation results, the weight coefficient of human influence can be set to 35.4; Similarly, the weight coefficient of safety indicators of machinery and facilities can be set to 35.4. The weighting coefficients of safety indicators for raw materials and excipients are 18.9, 20.2, 13.2 and 12.3 respectively for management methods and operation methods. Of course, the implementation of safety culture training and system construction at all levels of enterprises is conducive to the improvement of safety management level [12].

4.2. Determination of Safety Grade of Safety Management Indicators in Food Enterprises

Firstly, the index of human in food enterprise safety management system is analyzed by using safety checklist. According to table 3, the safety evaluation score of human index is 82.22. According to Table 1, the safety level of human is three levels, which belongs to the critical safety level. From Table 2, we can see that the main problems of human safety indicators are: inadequate drilling of emergency plans for accidents by general managers and safety managers; inadequate awareness of workplace and job hazards by employees; inadequate awareness of employees'safety attitudes towards potential safety hazards and job hazards; and the ability of team leaders to deal with abnormal work conditions. Insufficient strength and responsiveness; emergency evacuation of front-line personnel, self-help and rescue knowledge and skills are insufficient, and so on. The United States Security Council statistics that 90% of safety accidents are caused by unsafe human behavior [13]. Therefore, safety management measures must be taken from the above specific aspects to improve the safety level of human indicators.

Table 3: Human factor safety inspection.

Number	Content	Criteria	Score
1	Improvement of Safety System Established by Responsible Persons of Food Enterprises	5	4
2	On the Establishment of Safety Responsibility System by Responsible Persons	5	4
3	Responsible person's investment in safety management	5	4
4	Responsible Persons'Status of Safety Management Institutions and Personnel	5	4
5	Safety Inspection and Inspection of Safety Management Personnel	5	4
6	Three-level Safety Education and Emergency Rescue Knowledge	5	5
7	Facility Operators'Perception of Job Risk	5	4
8	Employees'Ability to Handle and Response to Abnormal Work	5	4
9	Knowledge of emergency evacuation, self-help and rescue of workers	5	4
Result = Score / Total Score =37/45=82.22% take the index value: 82.22			

Table 4: Safety inspection of machine indicators.

Number	Content	Criteria	Score
1	Reliability of Equipment Source of Food Machinery	5	5
2	Safety Design Consistency of Hanger Rope in Food Workshop	5	4
3	Accessories for locking of high temperature heating furnace in food workshop	5	5
4	Safety status of safety equipment	5	5
5	Regular inspection and maintenance of food equipment	5	4
6	Human machine matching degree of food machinery and equipment	5	4
7	Damage Risk of Equipment in Food Workshop	5	4
8	Corrosion Hazard and Pressure Testing of Food Steam Tanks	5	4
9	Regular maintenance of machinery and equipment	5	4
Result = Score / Total Score =39/45=86.66% take the index value: 86.67			

Table 5: Indicators of material safety inspection.

Number	Content	Criteria	Score
1	Preliminary Quality Assessment of Food Raw Materials	5	5
2	Disinfection and Anti-mildew of Food Transportation Vehicles	5	5
3	Sorting and Processing of Food Raw Materials	5	5
4	Pressure Hazard of Food Supplementary Materials	5	5
5	Storage of Semi-finished Food Products and Temperature and Humidity Control	5	4
6	Fire and Explosion Hazard of Auxiliary Materials in Food Production	5	4
7	Reaction Control of Material and Food Composition of Food Sealed Open Cans	5	5
8	Vacuum Quality Control of Food Canned and Bagged	5	5
Result = Score / Total Score = 38/40=95% take the index value: 95			

Table 6: Indicator safety check of method.

Number	Content	Criteria	Score
1	Possibility of poisoning hazards in food production	5	5
2	Possibility of Fire Risk in Food Production	5	5
3	Possibility of Explosion Danger in Food Production	5	5
4	Reasonable Feasibility of Food Production Procedure Design	5	4
5	Risk degree of food production project process	5	4
6	The degree of improper operation of methods in food production	5	3
7	Main Hazardous Scope in Food Production	5	4
8	Rationality of personnel arrangement in food production process	5	4
Result = Score / Total Score = 34/40=85% take the index value: 85			

Table 7: Index safety check of external environment.

Number	Content	Criteria	Score
1	Significant hazards of the environment around the production site	5	5
2	Safety Distance between Production Site and Enterprises with Major Hazardous Sources	5	5
3	Distance of Disturbance between Neighbouring Residential Areas and Production Sites	5	5
4	Rationality of Distance between External Rescue Team and Place of Activity	5	4
5	Reasonable Feasibility of Internal Layout Structure of Production Sites	5	5
6	Feasibility of Safety Planning and Design of Production Base	5	4
7	Rationality of Fire Protection Facilities Allocation in Production Sites	5	5
8	Safety warning signs in important parts of production sites	5	4
9	Rationality of Fire Channel Design in Production Sites	5	4
10	The Openness of Fire Control Channels in Production Sites	5	5
	Result = Score / Total Score = 46/50=92% take the index value ：92		

According to Table 4, the safety evaluation score of the machine is 80, According to Table 1, the safety grade of the machine is four, The safety control of food machinery should be strengthened. The score of Table 5 is 95, According to Table 1, the safety level is five, which indicates that the food company has strict control over the safety of materials. The score of Table 6 is 85, and the grade is four, which indicates that the process management needs to be improved in depth. Table 7 has a score of 92. According to Table 1, the safety level is five. The food enterprise has always attached importance to environmental control and achieved results. From this we can see that food safety is mainly controlled by people, so the weight index of people is relatively high, and people are a highly dynamic variable.

4.3. Determination of Safety Grade of Safety Management Indicators in Food Enterprises

The safety evaluation score of food enterprise safety management system can be obtained by the safety evaluation score of each index and its weight. According to the algorithm in 2.3, the safety evaluation score of food enterprise safety management system is

$$G = 82.22 \times 35.4\% + 86.67 \times 18.9\% + 95 \times 20.2\% + 85 \times 13.2\% + 92 \times 12.3\% = 87.22$$
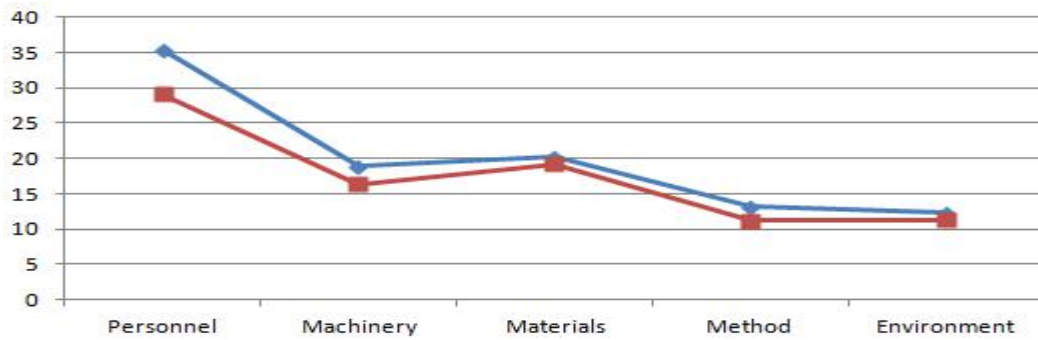
Figure 1: Ideal state comparison table.

According to Table 1, the safety level of the safety management system of the food enterprise is four, belonging to the middle safety level. Managers should take measures to improve its safety level. Although the scale and benefit of the enterprise have significant social influence, the higher the score, the better the food enterprise can reflect. Safety management level. The human factor in the index belongs to three levels, and the machine law belongs to four levels. Therefore, safety management measures should be taken from three aspects of the human-machine law. Material safety is basically controlled by source and process, and environment is the peripheral factor of project operation. These two management efforts need to be sustained.

The most important factor of safety management is the shaping and cultivation of human resources. According to the statistics of human resources department, more than 50% of the employees come from small towns around the enterprise. The enterprise has contributed to solving the employment of nearby labor force. According to the actual investigation, the inappropriate quality of people is the main cause of accidents. This kind of food enterprises should lay stress on strengthening the safety management foundation of enterprises from the quality of people, including the selection of personnel, the process of educating people should always run through the inspection of safety quality, and the construction of safety culture of enterprises should be emphasized. Safety culture is safety management[14].

5. Conclusions

(1) Using the method of system safety checklist analysis, the safety management system of food enterprises is decomposed into five safety management indicators of man-machine material law ring. MSCA method is adopted to establish the safety management evaluation model and determine the safety level of safety management indicators of food enterprises. This is the correct way to judge the level of safety management of food enterprises.
(2) Applying the established safety management model of food enterprises to evaluate the safety management of relevant enterprises. The results show that the safety level of the enterprise safety management system is four levels. Measures should be taken from three aspects of human-machine law to improve the safety level of the food enterprise safety management system.

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