

Research Article

Analysis of Restraining Factors in Food Quality of Primary and Middle School Canteens in Bengbu City Based on Analytic Hierarchy Process

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Abstract: In order to make the research into restraining factors in food quality and further improve food quality of primary and middle school canteens in Bengbu city, the paper firstly bases itself on the investigation and consulting into some certain canteens and relevant managers in Bengbu region, preliminarily constructs hierarchy structure model on factors influencing food quality security of primary and middle school canteens in Bengbu region and then figures out combination weight of each index by employing analytic hierarchy process. After eliminating the minimum weight factor of each secondary index subordinate to its first grade index, the structure chart can be obtained, which deals with restraining factors in food quality of primary and middle school canteens in Bengbu city, in addition, the top 6 restraining factors which function most powerfully in this field can be obtained, which is of great significance in improving food quality and preventing food security incidents in primary and middle school canteens in Bengbu region.

Keywords: Analytic hierarchy process, food quality, primary and middle school, security

INTRODUCTION

With the rapid development of China's economy, the pace of people's life speeds up, as a result, it is very common for primary and middle school students to have lunch in school canteens (Wu *et al.*, 2008). The number of primary and middle school students in China, a country with large population, has exceeded 200 million. In China's primary and middle school canteens, the number of diners is large and the diners tend to be crowded, so alimentary toxicosis and some other foodborne diseases are likely to be more destructive (Liang and Wu, 2011). Actually, food security incidents frequently occur in China's primary and middle school canteens. In 3rd, 9, 2001, soymilk poisoning incident happened in 16 primary and middle schools subsidiary to Jilin Petrochemical Corporation. In 19th, 10, 2013, steak toxicosis occurred to 10 students of No. 6 Middle School of Mengcheng county, Anhui province. In 25th, 9, 2014, alimentary toxicosis happened to 62 pupils of Gulei Branch of Zhangzhou Experimental Primary School. Therefore, for the purpose of reducing food security incidents in primary and middle school canteens and further improving food quality of primary and middle school canteens in Bengbu city, the paper is based on the investigation into some certain canteens and relevant managers of primary and middle school canteens in Bengbu region and it will preliminarily construct hierarchy structure model on factors influencing food quality security, employ analytic hierarchy process to make screening

index in the system and eventually find out the major restraining factors in food quality of primary and middle school canteens.

MATERIALS AND METHODS

Brief introduction to analytic hierarchy process: Analytic Hierarchy Process (AHP), was put forward in the 1970s by Professor T.L. Saaty of University of Pittsburgh of America (Saaty, 1988; Yu and Fu, 2004). It contains both subjective logical judgment and analysis and objective accurate calculation and reasoning, which is defined as a sort of quantitative and qualitative combined, systematic and hierarchical decision analysis method.

Basic steps of analytic hierarchy process:

Step 1: Constructing hierarchy structure model: In the step, the factors included in problem are required to be divided into groups. Each group is regarded as a hierarchy and all the groups should be ranked in the form of top hierarchy (target hierarchy), some intermediate hierarchy (standard hierarchy) and bottom hierarchy (solution hierarchy).

Step 2: Constructing judgment matrix: Make each factor element which has downward membership relationship (called standard) as the first element in judgment matrix (in the top left corner) and its

Table 1: Pairwise comparison matrix

	a_1	a_2	a_3
a_1	a_{11}	a_{12}	a_{13}
a_2	a_{21}	a_{22}	a_{23}
a_3	a_{31}	a_{32}	a_{33}

Table 2: 1-9 level scale method

a_i Compared with a_j	Quantitative value
a_i is as important as a_j	1
a_i is slightly more important than a_j	3
a_i is more important than a_j	5
a_i is much more important than a_j	7
a_i is far more important than a_j	9
importance degree is between anterior odd numbers	2, 4, 6, 8
$a_{ji} = 1/a_{ij}$	reciprocal

Table 3: Random consistency index

Order	1	2	3	4	5	6	...
RI	0	0	0.58	0.90	1.12	1.24	...

Table 4: Hierarchy structure model on restraining factors in food quality security of primary and middle school canteen

First-grade indexes	Secondary indexes	Combined weight
Purchase link $B_1(0.38)$	Staff quality $C_{11}(0.25)$	0.095
	Food material quality $C_{12}(0.38)$	0.144
	Safety consciousness $C_{13}(0.23)$	0.087
	Professional competence $C_{14}(0.14)$	0.053
Storage link $B_2(0.26)$	Storehouse floor space $C_{21}(0.39)$	0.101
	Food classification storage status $C_{22}(0.20)$	0.052
	Storehouse infrastructure $C_{23}(0.26)$	0.068
	Internal and external environment of storehouse $C_{24}(0.15)$	0.039
Processing link $B_3(0.20)$	Processing apparatus safety conditions $C_{31}(0.32)$	0.064
	Processing program safety conditions $C_{32}(0.46)$	0.092
	Processing site floor space $C_{33}(0.22)$	0.044
Edible link $B_4(0.16)$	Tableware hygiene $C_{41}(0.45)$	0.072
	Pre-sales inspection status $C_{42}(0.31)$	0.050
	Dining place hygiene $C_{43}(0.24)$	0.038

subordinate elements are successively ranked one by one in the subsequent first row and column (Bian and Hou, 2005), which is shown by Table 1. The value of a_{ij} means the importance of factor a_i relative to a_j , which is shown by Table 2.

Abbreviated:

$$A = \begin{pmatrix} a_{11} & a_{12} & a_{13} \\ a_{21} & a_{22} & a_{23} \\ a_{31} & a_{32} & a_{33} \end{pmatrix}$$

Step 3: Weight vector calculation and consistency checking: As to each judgment matrix (such as A), λ_{\max} we can be applied to calculate maximum eigenvalue and corresponding feature vector; coincidence indicator

$$CI = \frac{\lambda_{\max} - n}{n - 1}, \text{ random consistency index } RI$$

(value is shown in reference Table 3) and consistency ratio $CR = CI/RI$ can be employed in consistency checking. If $CR < 0.1$, the result shows this judgment matrix accords with consistency checking and feature vector (after normalization) is equal to weight vector, otherwise, pairwise comparison matrix should be reconstructed (Chen *et al.*, 2010).

Step 4: Combined weight vector calculation and combined consistency checking.

RESULTS AND DISCUSSION

Constructing hierarchy structure model: Based on the investigation into some certain canteens as well as consulting relevant managers of primary and middle school canteens in Bengbu region including Bengbu Muyuan School, Bengbu Second Experimental Primary School, Bengbu Xincheng Experimental School and Bengbu No. 6 Middle School, the paper preliminarily constructs hierarchy structure model on restraining factors in food quality security of primary and middle school canteens in Bengbu city, which is shown in Table 4.

Constructing judgment matrix: Here, first-grade index processing link and its subordinate 3 secondary indexes are illustrated to explain construction of judgment matrix. Some relevant experts are invited to construct judgment matrix on the basis of mutual importance level of 3 secondary indexes and 1-9 level scale method.

Weight vector calculation and consistency checking:

By means of sum method (Jiang, 1987), maximum eigenvalue can be figured out, with the result $\lambda_{\max} = 3.002$, corresponding feature vector $W_{B_3-C} = (0.32 \ 0.46 \ 0.22)$ and $CI = 0.001$. Referring to Table 3, $RI = 0.58$, so $CR = \frac{0.001}{0.58} \approx 0.002 < 0.1$. Therefore, this

judgment matrix accords with consistency checking and vector W_{B_3-C} is the weight vector.

In the same way, other various class weight vectors are as follows:

$$W_{B_1-C} = (0.25 \ 0.38 \ 0.23 \ 0.14),$$

$$W_{B_2-C} = (0.39 \ 0.20 \ 0.26 \ 0.15),$$

$$W_{B_4-C} = (0.45 \ 0.31 \ 0.24), \quad W_B = (0.38 \ 0.26 \ 0.20 \ 0.16)$$

Combined weight calculation: Based on the method in document (Jiang, 1987), the calculation result of combined weight is shown in Table 4.

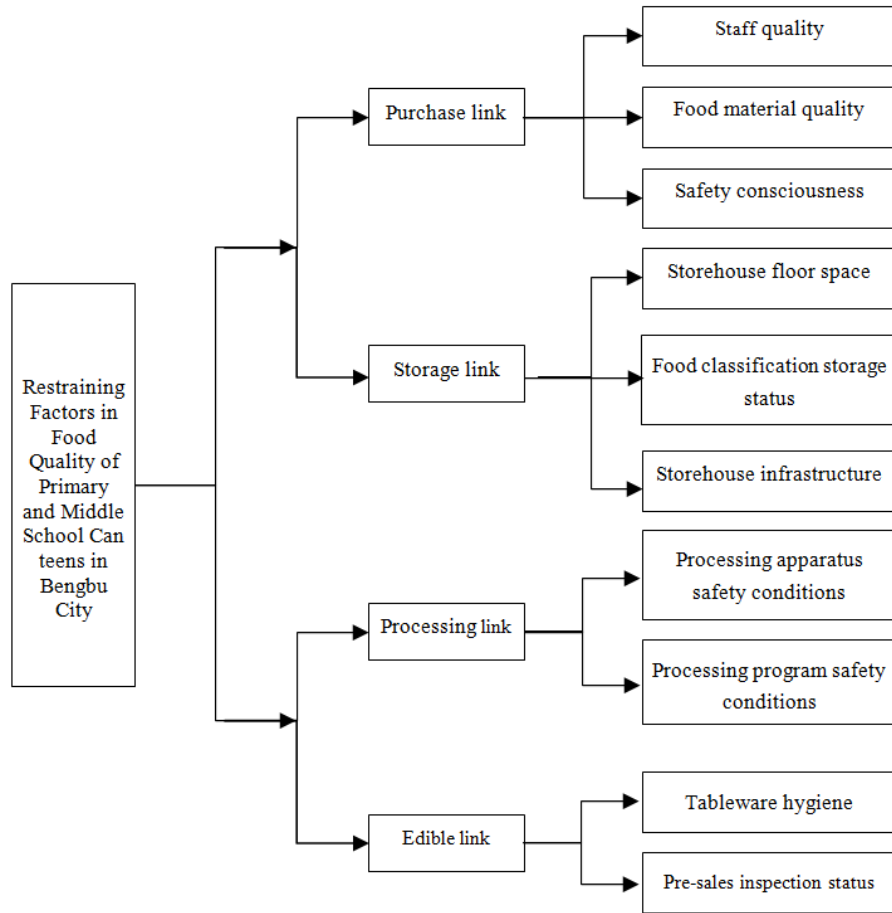


Fig. 1: Hierarchical chart of restraining factors in food quality of primary and middle school canteens in Bengbu city

Analysis of calculation result:

Result 1: After eliminating a factor that has the least effect on each corresponding first-grade index, the paper obtains the hierarchical chart on restraining factors in food quality security of primary and middle school canteens in Bengbu city, which is shown in Fig. 1.

Result 2: According to the calculation result based on combined weight, of all the restraining factors in food quality security of primary and middle school canteens in Bengbu city, the top 6 ones are food material quality, storehouse floor space, staff quality, processing program safety conditions, safety consciousness and tableware hygiene.

CONCLUSION

Food quality security problem in primary and middle school canteens is common nowadays. The paper preliminarily constructs hierarchy structure model on factors influencing food quality security of primary and middle school canteens in Bengbu region and then figures out combination weight of each index by employing analytic hierarchy process. After

screening combined weight of each index, the paper obtains the structure chart presenting restraining factors in food quality of primary and middle school canteens in Bengbu city, besides, the top 6 factors influential most in this field are put forward, which is of great significance in effectively avoiding in such vicious incident as alimentary toxicosis in primary and middle school students, ensuring physical and mental health of them and maintain social stability.

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