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Research on public health epidemic prevention system in Chinese construction industry

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Abstract: At present, China's construction industry professionals are mainly migrant workers, the industry is characterized by population, fluidity big, poor living environment, workers' quality is generally not high, is a typical prone to the spread of the disease, as a result, public health and epidemic prevention work of the construction industry is an urgent need to pay attention to the problem.Based on field research, this paper adopts brainstorm method to construct the index of public health epidemic prevention system of construction projects.Through the establishment of the binary fuzzy analytic hierarchy process, the weight parameters of each epidemic prevention index are given.Then by using the fuzzy comprehensive evaluation method and the designed two-point evaluation standard, the public health epidemic prevention ability evaluation system of the construction industry is constructed. Finally, the rationality and accuracy of the evaluation system are verified by the application analysis of specific engineering examples. The results show that the constructed public health epidemic prevention system has good applicability and can accurately and objectively reflect the public health epidemic prevention ability of the project department.

Keywords: construction engineering; public health; system construction

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1 introduction

The coronavirus in 2019 is a serious public health events, according to who on March 24, 2020, according to a report global infections have more than 300000 cases, the event is not only caused great damage to people's health, but also brought significant influence on global social economy, it has to make us reflect on the current construction situation of the public health and epidemic prevention system.At present, China's construction industry belongs to the labor-intensive industries, the site of the project group of construction personnel, and such personnel in the aspect of eating, working, living and entertainment with a high population aggregation, fluidity big, poor living environment, and personnel quality is generally not high [1], is a typical prone to the spread of the epidemic disease;Therefore, the public health and epidemic prevention safety of such social groups is a problem that must be considered.

Through various literatures, found that the scholars at home and abroad in the field of construction of public health and epidemic prevention research problems, rarely Cheng Rui on-site health and control condition of the engineering construction project is studied [2], li-xin sun to explore method and the management of occupational health [3], Ijaz Ahmad scholars studied the small enterprise workers' occupational health [4]. Influenced by the coronavirus, China academy of building standard design chief architect Liu Dongwei call to focus on residential construction of health and health design [5], vice President of the China international economic and exchange center, huang qifan, reform of China's public health and epidemic prevention system gives some proposal [6], Shen Yuetian scholars in occupational disease prevention will be coronavirus gives some countermeasure [7], Pan Xingchen scholars suggest that wants to be a lesson to a 2019 - nCoV, other types of infectious disease prevention [8];However, the public health epidemic prevention system of construction projects has not been systematically studied.Therefore, this paper attempts to carry out a systematic study on the public health epidemic prevention system of the construction industry in China, and establish the index and evaluation system of the epidemic prevention system, so as to provide theoretical support and basic work for improving the public health epidemic prevention capacity of the construction industry.

2 Construct indicators of public health epidemic prevention system for construction projects

2.1 selection principles of system indicators

(1) scientific nature

The index can objectively reflect the public health epidemic prevention ability of the construction project, conform to the scientific law of the prevention and treatment of infectious diseases in medicine, and accurately and comprehensively summarize the attribute content of the construction project and the construction personnel in epidemic prevention.

(2) operability

The selected indicators conform to the actual situation of the current construction industry, that is, do not use the traditional outdated indicators, should not be too far ahead of the application, easy to achieve, to ensure that the majority of construction enterprises meet the realistic conditions.

(3) streamlining

Each index is simple and independent, which only expresses one aspect of the evaluation object's attributes, without too many redundant attributes.

2.2 selection of system indicators

According to the statistics in the first quarter of 2019, 9 infectious diseases, including malaria, cholera and plague, are causing more human diseases globally, among which measles, dengue fever and Middle East respiratory syndrome are the main manifestations in Asia [9].In addition, tuberculosis, AIDS and hepatitis b virus are also prominent epidemic prevention targets [10].There are differences in the transmission routes of different types of viruses, but there are mainly three modes of transmission, namely, droplet transmission, humoral transmission and fecal-oral transmission [11]-[12], whose influence on human beings is determined by comprehensive factors such as environmental conditions, transmission mechanism and management measures [13].Therefore, when determining the representative index of public health epidemic prevention ability of the construction industry, it should be selected according to the living and working characteristics of the people in the construction industry in China and the transmission characteristics of infectious diseases.With reference to the health of the People's Republic of China standard assembly "[14], the occupational health supervision personnel on-site inspection guide [15]," building construction safety inspection standards "[16] and other relevant national standard, and combining with the characteristics of transmission of infectious diseases and 10 experts (2, two medical practitioners, supervision engineer 2, the construction unit engineer, two engineers, two construction unit safety watchdog engineer) using the brainstorming method, combining with the construction site environment and the characteristics of construction workers working and living, in accordance with the method of prevention and control of infectious disease epidemic prevention system is divided into daily to two kinds of preventive measures and emergency disposal ability.According to the method of three-level classification, 2 first-level indicators, 9 second-level indicators and 20 third-level indicators were established. The epidemic prevention system indicators and interpretation are shown in table 1:

Table 1. index and interpretation of epidemic prevention system

Primary index	secondary index	tertiary index	Index definition
Daily precautions(A_1)	Responsibility system(B_1)	Leadership responsibility(c_1)	The project manager has the main responsibility for epidemic prevention
		Division of responsibilities(c_2)	According to the number of construction site reasonably equipped with full-time or part-time health commissioner
	Routine preventive management(B_2)	Epidemic prevention education(c_3)	By means of propaganda, video, poster and knowledge manual, etc., the construction personnel will be admitted to the site and receive regular epidemic prevention education
		Health check(c_4)	Carry out regular sanitary inspection to the dormitory, canteen and office space
	Living environment(B_3)	Collective dormitory(c_5)	According to the standard standard area and the number of people living in a single room to set up staff dormitory
		The room that defend bath(c_6)	Provide flush toilet and shower facilities according to the standard
		Activities(c_7)	Clean and disinfect the place regularly
	Food safety(B_4)	Food material purchasing management(c_8)	Food materials are purchased through formal channels
		Eating style(c_9)	Use separate plate system, avoid the same food with the way of eating
		Tableware management(c_{10})	Clean and disinfect the tableware regularly
	Personnel health records(B_5)	Health records(c_{11})	Pre-job physical examination, establish personal health records
		Disease report and identification management(c_{12})	After the occurrence of diseases in the venue, the personnel should report to the health commissioner in time, for the abnormal symptoms should be sent to the hospital in time for diagnosis and treatment, if necessary, isolation observation
	Site access management(B_6)	Staff go out to report management(c_{13})	The employee shall report to the health commissioner if he/she goes to another place or to a special environment
		Registration administration of foreign personnel(c_{14})	Non-staff enter the venue for registration and management
Emergency handling capacity(A_2)	The emergency ability(B_7)	The emergency response plan(c_{15})	Formulate emergency plans for epidemic prevention according to regional characteristics
		Emergency drill(c_{16})	Carry out emergency drills for epidemic prevention and control in accordance with seasonal characteristics
	Linkage mechanism(B_8)	Medical linkage(c_{17})	According to the location of the project, set up a designated hospital, health center and other medical institutions, in case of sudden disease timely treatment
		Outbreak control linkage(c_{18})	Define the local health supervision agency of the project, timely report the outbreak and cooperate with the joint disposal
	Emergency supplies(B_9)	Protective equipmentc_{19}	According to the number of people in the store reserve an appropriate amount of masks, gas masks and other protective equipment
		Disinfection equipment(c_{20})	According to the characteristics of the project and the site environment with the appropriate disinfection equipment and supplies

2.3 determine the index weight

2.3.1 overview of weighting methods

The commonly used methods to determine the weight include rough set importance method, analytic hierarchy process, expert scoring method and fuzzy decision method, which can be classified as subjective weighting method, objective weighting method and combination weighting method.The advantage of subjective weighting method is that it is practical and avoids the situation that the research conclusion is contrary to the reality.The advantage of objective weighting method is that it has a strong mathematical theoretical basis, but the disadvantage is that it is difficult to obtain the original data, and the calculation is complex, and it is easy to produce research conclusions contrary to the reality due to the lack of information elements. Combinatorial weighting method can get real and reliable decision conclusion with limited original data.

2.3.2 establish the binary fuzzy decision analytic hierarchy process

Analytic hierarchy process (ahp) is the most widely used method to determine the weight of multiple indicators.However, according to a paper published by psychologist Cowan N in 2001, the maximum working memory span of normal human brain is 4, which is not 7±2 as proposed by Miller in 1956. That is, when the factor index is more than 4, the brain cannot make accurate judgment [17]. Therefore, it is difficult to control the accuracy using the traditional analytic hierarchy process.Epidemic prevention index weight based on the research, to improve the analytic hierarchy process (ahp), USES the binary fuzzy decision analytic hierarchy process (ahp) to determine index weight, this method can make use of threshold subjective comparison results to fuzzy discrete, then according to the results of sorting, the relative importance of the objective parameters to reduce the error due to subjective factors.

The domain U= $\{c_1,c_2,c_3... c_n\}$, R C, F $(c_i / c_j) = R_{ij}$, where R_{ij} represents the importance of c_1 for R than c_2 for R, and R_{ij} satisfies the following formula:

$$\begin{cases} R_{ij} = 0, 0 \le R_{ij} \le 1 \\ R_{ij} + R_{ji} = 1 \end{cases} \tag{1}$$

Then the fuzzy priority relation matrix of C is:

$$\begin{bmatrix} R_{11} & \cdots & R_{1j} \\ \vdots & \ddots & \vdots \\ R_{i1} & \cdots & R_{ij} \end{bmatrix}_{n\times n}$$

If the threshold $\theta \in [0,1]$ is taken, the θ truncation matrix is:

$$\begin{bmatrix} R_{11}^{\theta} & \cdots & R_{1j}^{\theta} \\ \vdots & \ddots & \vdots \\ R_{i1}^{\theta} & \cdots & R_{ij}^{\theta} \end{bmatrix}_{n\times n} ,\ where\ R_{ij}^{\lambda} = \begin{cases} 1, R_{ij} \rangle \theta \\ 0, R_{ij} \le \theta \end{cases}$$

According to the reduction of 1 /n, the threshold value θ is gradually reduced. When the θ truncation matrix appears for the first time in the i_1 row except for the diagonal line, all the elements are equal to 1, then R_{i1} is regarded as the first important object element; continue to reduce the threshold θ, When the n-1 order sub-matrix has all elements except diagonals equal to 1, it is considered that R_{i1} is the second most important object element, and the last important object element R_{in} is found in turn, then the importance ranking of each element can be obtained $\{R_{i1}, R_{i1} ... R_{in}\}$, the judgment matrix [R] of each evaluation element is constructed with a comparison scale of 1 to n levels, the maximum eigenvalue θ_{max} of the judgment matrix [R] is calculated, and after the consistency ratio CR is checked, the sum method is used The weight of each element in the judgment matrix [R]:

$$W_i = \frac{1}{n}\sum_{1}^{n}\frac{c_{ij}}{\sum_{1}^{n} c_{ij}}$$

2.3.3 Data operation

Assuming that the discourse domain is the third-level indicator of the epidemic prevention system, that is, C = $\{c_1,c_2,c_3...c_{20}\}$, the important levels are divided into first-class, second-class, and third-level, and the quantitative processing is recorded as 3,2,1, respectively. Expressed by D, then D={3,2,1}, 2 doctors and 8 engineers were hired to form a review group, and the results obtained are shown in Table 2.

Table 2. comparison table of index importance

$C_i \to C_j$	D			R_{ij}
	3	2	1	
$c_1 \to c_2$	9	1	0	0.97
$c_1 \to c_3$	9	1	0	0.97
$c_1 \to c_4$	7	3	0	0.90
		⋮		
c19→c20	0	2	8	0.40

Available fuzzy priority relationship matrix:

$$\begin{bmatrix} 1 & 0.97 & 0.97 & \cdots & 1 \\ 0.03 & 1 & 0.9 & \cdots & 1 \\ 0.03 & 0.1 & 1 & \cdots & 1 \\ \vdots & \vdots & \vdots & \ddots & \vdots \\ 0 & 0 & 0 & \cdots & 1 \end{bmatrix}_{20\times 20}$$

Taking θ=0.95, the $\theta_{0.95}$ cut matrix can be obtained:

$$\begin{bmatrix} 1 & 1 & 1 & \cdots & 1 \\ 0 & 1 & 0 & \cdots & 1 \\ 0 & 0 & 1 & \cdots & 1 \\ \vdots & \vdots & \vdots & \ddots & \vdots \\ 0 & 0 & 0 & \cdots & 1 \end{bmatrix}_{20\times 20}$$

Because the row where c1 is located is all 1, so c_1 is the first important indicator element. After removing the row and column where c_1 is located, the sub-matrix is obtained:

$$\begin{bmatrix} 1 & 0.9 & \cdots & 1 \\ 0.1 & 1 & \cdots & 1 \\ \vdots & \vdots & \ddots & \vdots \\ 0 & 0 & \cdots & 1 \end{bmatrix}_{19\times 19}$$

Similarly, taking the values of $\theta_{0.9},\theta_{0.85}...\theta_{0.01}$ in turn, the descending sorting set of each index factor can be obtained as{(c_1,c_{18}),(c_2,c_3),(c_5,c_9),(c_6,c_8,c_{10}),(c_4,c_{12}),(c_{16}, c_{17}),(c_7),(c_{11}),(c_{14}),(c_{13}),(c_{15}),(c_{20})(c_{19})}. According to the 13 levels in the sorted set, the relative importance parameters are given (see Table 3):

Table 3. relative importance parameters

C_i VS C_j	Ranking Order												
	1	2	3	4	5	6	7	8	9	10	11	12	13
Quantified value	13	12	11	10	9	8	7	6	5	4	3	2	1

According to Table 3, 20 indicators of 13 grades are used to construct a judgment matrix [R]:

$$\begin{bmatrix} 1 & 1.08 & 1.08 & \cdots & 6.5 \\ 0.92 & 1 & 1 & \cdots & 6 \\ 0.92 & 1 & 1 & \cdots & 6 \\ \vdots & \vdots & \vdots & \ddots & \vdots \\ 0.15 & 0.17 & 0.17 & \cdots & 1 \end{bmatrix}_{20\times 20}$$

The maximum eigenvalue of the judgment matrix λ_{max}=20, consistency index $CI = \frac{\lambda_{max} - n}{n-1} = 0$, consistency ratio $CR = \frac{CI}{RI_{20}} = 0\langle 0.1$, consistency test passed.

Calculate the weight of each factor in the judgment matrix [R] according to Equation 2 and normalize it to obtain the weight parameters W = (0.08,0.07,0.07,0.05 ,0.07,0.06,0.04,0.06,0.07,0.06 , 0.04, 0.05, 0.02, 0.03, 0.02, 0.05, 0.05, 0.08, 0.01, 0.01).

3 Build a public health and anti-epidemic capacity evaluation system

3.1 Introduction to Fuzzy Comprehensive Evaluation Method

The fuzzy comprehensive evaluation method is a mathematical method proposed by automatic control expert Lotfi Aliasker Zadeh to study the problem of indeterminate boundary. It is used to analyze the fuzzy boundary and cannot accurately quantify things[18]-[19]. In the research of fuzzy evaluation of management system, according to whether factors can continue to be decomposed, system evaluation problems can be divided into single-level fuzzy evaluation and multi-level fuzzy evaluation.

3.2 Establish fuzzy evaluation set

3.2.1 Evaluation index set

The credit evaluation system includes three levels of elements, a total of 15 single-level factors, namely r_1,r_2,r_3...$r_1$5, represented by the set R, then R={r_1,r_2,r_3...r_{15}}.

3.2.2 Index weight set

Let W denote the set of weights of 20 indicators, then W= {w_1,w_2,w_3...w_{15}}={0.08,0.07,0.07...0.01}.

3.2.3 Fuzzy evaluation language set

Refer to the scoring standard rules of the index, set the fuzzy evaluation language set to 5 elements, the language is expressed as grade difference, poor, general, good and excellent. In order to increase the effect of various factors on the evaluation results, the evaluation criteria are discretely processed , Giving each language element scores of 0,5,10,15 and 20, respectively, expressed by the set V, then V={v_1,v_2,v_3,v_4,v_5}={0,5,10,15,20}.

3.3 Set operations

3.3.1 Fuzzy evaluation relation matrix

To establish a fuzzy relationship between the set R of each element of the credit evaluation index and the set V of language levels, and to form the relationship matrix S, there are:

$$S = \begin{bmatrix} S_{1,1} & \cdots & S_{1,15} \\ \vdots & \ddots & \vdots \\ S_{15,15} & \cdots & S_{15,15} \end{bmatrix}$$

In the matrix: S_{ij} indicates the degree of membership of the evaluation index r_i.

3.3.2 Fuzzy evaluation result matrix

Perform fuzzy comprehensive calculation on the index to obtain the fuzzy evaluation result matrix Z=W×S, then:

$$\{Z_1,Z_2,Z_3...Z_{15}\} = (W_1,W_2,W_3...W_{15})\begin{bmatrix} S_{1,1} & \cdots & S_{1,15} \\ \vdots & \ddots & \vdots \\ S_{15,15} & \cdots & S_{15,15} \end{bmatrix} \quad (3)$$

3.3.3 Calculate the evaluation score

$$M = (Z_1,Z_2,Z_3\ .\ .\ .\ Z_{15})(V_1,V_2,V_3\ldots V_5)^T \quad (4)$$

3.4 Classification and classification standards for epidemic prevention capability

In the classification of evaluation results, it is generally used to use the equal division system, that is: if X is n-level, then X+m is n+1 level; however, this classification standard has certain defects and ignores the pyramid effect of the score For example, it is easy to increase 60 points by 5 points for exam results, and it is not easy to increase 5 points by 90 points. The higher the score, the more difficult it is to increase. Therefore, when designing the credit rating classification standard, the dichotomy system is adopted, and the mathematical expression of the standard cut-off point is as follows:

$$f(x)=\begin{cases} c\text{ , c is a constant , } x=0 \\ \sum_{1}^{n}\frac{f(x-1)}{2}, x\geq 1 \end{cases} \tag{5}$$

The 1000-point system is commonly used in the project, and a 5-level evaluation standard is used, so let C = 1000, and the content of the credit rating classification standard is shown in Table 4.

Table 4. credit rating classification standard table

Grade	Score Interval
I	(938, 1000]
II	(876, 937]
III	(751, 875]
IV	(501, 750]
V	[0, 500]

4 Application analysis

4.1 Data collection

The Sichuan Evergrande Tianfu Cultural Tourism City project was selected as the research object. Five engineers and two physicians were hired to score the project construction area and living area according to Table 5.

Table 5. items check the data table

R	V				
	0	5	10	15	20
c_1	0	0	0	1	6
c_2	0	0	1	3	3
c_3	0	0	0	0	7
			⋮		
c_{20}	0	2	3	2	0

4.2 Data operation

Turn Table 5 into a fuzzy relationship matrix S about index factors and language evaluation:

$$S=\begin{bmatrix} 0 & \cdots & 6 \\ \vdots & \ddots & \vdots \\ 0 & \cdots & 0 \end{bmatrix}$$

Calculate the fuzzy evaluation result matrix Z according to equation (3):

$$Z=(0.08,0.07\cdots 0.01)\begin{bmatrix} 0 & \cdots & 6 \\ \vdots & \ddots & \vdots \\ 0 & \cdots & 0 \end{bmatrix}$$

The operation results: Z = (0.45,0.88,1.68,1.06,2.86)

Calculate the original evaluation score M_0 according to equation (4):

$M_0=(0.45, 0.88...2.86)(0, 5...20)^T$

Calculated:M_0=94.3

4.3 Anti-epidemic ability rating

Assuming that all the evaluations given by the 7 experts on the 20 indicators are full marks, the fuzzy relationship matrix

$$S_{max}=\begin{bmatrix} 0 & \cdots & 7 \\ \vdots & \ddots & \vdots \\ 0 & 0 & 7 \end{bmatrix}$$

According to formula (3) and formula (4), we can get M_{max}=138.6

Transform M_0 into a 1000-point system to obtain:

$M=M_0/ M_{max}\times 1000= 680$

According to the evaluation rules in Table 4, the project's public epidemic prevention capacity rating is IV, indicating that the public health epidemic prevention system is imperfect, which is basically consistent with the current situation of the construction industry's epidemic prevention system construction.

5 Conclusion

This paper is the first attempt to study the public epidemic prevention capacity system of China's construction industry by combining the transmission characteristics of infectious diseases.The system not only enriched the contents of China's public health epidemic prevention system, but also specialized the epidemic prevention system.Moreover, it can help government health departments, safety supervision agencies or construction enterprises to improve the health and epidemic prevention management ability of engineering projects, which has important application value and practical significance.

Public health epidemic prevention in the construction industry is an urgent problem that needs to be paid attention to.In the management of epidemic prevention work, it is necessary to first clarify the responsibilities of leaders and post responsibilities, strengthen the management of daily diet, living environment, disease report and identification management of construction personnel, carry out regular health inspection and emergency drills, and enhance the awareness of epidemic prevention of project personnel.In addition, the current construction of the epidemic prevention system in living areas is a neglected content, this paper has not yet considered the intelligent temperature measurement, big data analysis and other hightech applications in the epidemic prevention work, it is suggested that more scholars pay attention to the construction Project public health and epidemic prevention safety, further carry out relevant research.

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