Research on The Construction of Statistical Index System for The Evaluation of Emergency Management Ability of Public Emergencies In Colleges and Universities Based on Factor Model

Yu Dong [1, a, *], Jiahu Wei [2, b]

[1]School of Management Science and Engineering, Shandong Technology and Business University, Yantai, China
[2]School of Energy and Mining Engineering, China University of Mining and Technology-Beijing, Beijing, China
[a, *] Corresponding author e-mail: dongyu1987@sdtbu.edu.cn
[b]e-mail: 17865577135@163.com

Abstract

At present, colleges and universities are facing more and more public emergencies, and the ability of emergency management needs to be improved. Only by strengthening their own emergency management technology can colleges and universities further improve their emergency management ability and reduce or avoid casualties and property losses. Build a comprehensive emergency management platform and communication network system in colleges and universities based on big data and internet of things technology; Combined with public emergencies in colleges and universities, the paper preliminarily constructs the evaluation index system of public emergency management ability in colleges and universities. Based on the factor analysis model, the applicability of the evaluation system is tested and modified by SPSS software, and the evaluation index system of public emergency management ability in colleges and universities is finally determined.

Keywords-colleges and universities; emergency management capability; index system; factor model; statistical analysis

1. INTRODUCTION

With the accelerated integration of the new generation of information and communication technology represented by big data and artificial intelligence with traditional industries, as well as the vigorous development of 5G and internet of things, informatization plays an increasingly important role in social life. It is an urgent task for colleges and universities to actively promote the construction of emergency management in key areas such as information and communication, network infrastructure, radio and television, satellite navigation, internet of things, cloud computing, big data and smart city in the new era. At present, most colleges and universities in China have some problems, such as imperfect emergency informatization, lack of emergency rescue institutions, insufficient prevention of emergency mechanism, insufficient crisis response ability, unclear rights and responsibilities of relevant departments, which slow down the improvement of emergency management ability of colleges and universities to deal with public emergencies [1].

To improve the emergency management ability of colleges and universities, we must first recognize the current situation of emergency management ability of public emergencies in colleges and universities, and this requires a scientific and reasonable evaluation index system of emergency management ability in colleges and universities. Most of the existing evaluation index systems have many problems such as strong subjectivity, small scope and incomplete. Therefore, to understand the emergency management ability of colleges and universities, a reasonable and practical evaluation index system must be established [2].

2. PUBLIC EMERGENCIES AND EMERGENCY MANAGEMENT IN COLLEGES AND UNIVERSITIES

2.1 Definition and Classification of Public Emergencies in Colleges and Universities

On the basis of previous literature, combined with the relevant experts' summary of public emergencies in colleges and universities, the paper defines public emergencies in colleges and universities as [3]: sudden occurrence inside and outside the school, which has a certain connection with people or things in the school, may cause life loss and material loss of students, workers and social workers, and have a serious impact on the learning and living environment, and has the serious social consequence and endangers the social security the accident.

Through the collection and analysis of literature [4] and the investigation and analysis of the current situation of colleges and universities, the paper divides the public emergencies in colleges and universities into five categories: accident and disaster, public health, network public opinion and social security [2].

2.2 Construction of Comprehensive Emergency Management Platform and Communication Network System

Based on intelligent sensing, radio frequency identification, video image, lidar, aerial remote sensing and other sensing technologies, the college emergency management perception network, relying on the heaven and earth integrated emergency communication network, public communication network and low-power wide area network, and combined with the application requirements of college experimental safety monitoring and early warning and real-time dynamic monitoring of emergency treatment site, constructs a perception data acquisition system covering the whole region. The system can realize omni-directional, three-dimensional and blind spot free dynamic monitoring in Colleges and universities, provide data source for multi-dimensional comprehensive analysis of risk information, and further improve the school safety risk monitoring and early warning system. The construction of an emergency management integrated application platform and the communication network is shown in Fig. 1 and Fig. 2.
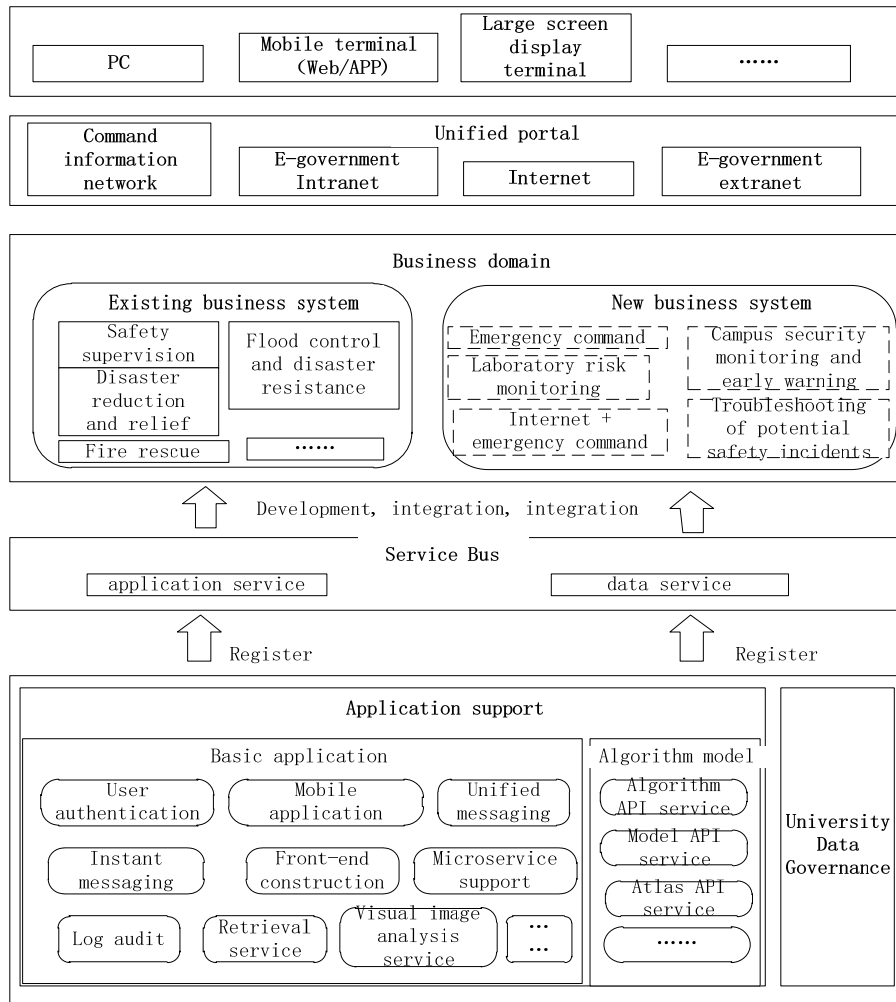

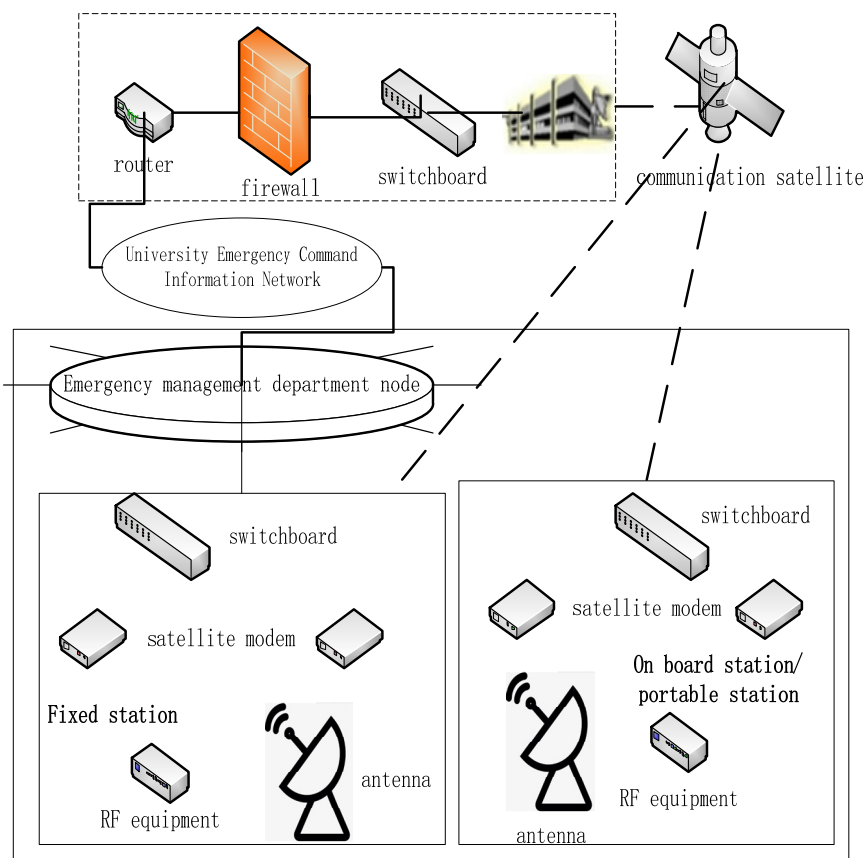Figure 1 Emergency management integrated application platform

Figure 2 Construction of the communication network system

3. PRELIMINARY CONSTRUCTION OF EVALUATION INDEX SYSTEM OF PUBLIC EMERGENCY MANAGEMENT ABILITY

Combined with the characteristics of the emergency management stage in colleges and universities, and considering the current situation of colleges and universities in China and the occurrence probability of different public emergencies in colleges and universities, the paper initially constructs an evaluation index system of public emergencies in colleges and universities [5-6].

The establishment of evaluation indicators should cover and reflect the ability of colleges and universities to respond to public emergencies to the greatest extent. The evaluation indicators are divided into 4 first-level indicators and 25 second-level indicators. The 4 first level indexes include prevention ability before public emergencies (A1), ability to deal with public emergencies (A2), recovery ability after public emergencies (A3), and guarantee ability after public emergencies (A4). The 25 secondary indicators corresponding to the 4 primary indicators are: compilation of emergency plan for colleges and universities (B1), investigation of hidden dangers in colleges and universities (B2), emergency warning for public emergencies in colleges and universities (B3), emergency team construction management (B4), status of emergency education (B5)

and detection of public emergencies in colleges and universities (B6); start speed of emergency plan (C1), analytical decision-making ability in emergency situations (C2), coping ability of on-site personnel (C3), emergency personnel deployment (C4), emergency supplies (C5) and information release(C6); accountability for public emergencies (D1), the ability to restore the environmental order in universities (D2), psychological counseling for university staff (D3), a summary of colleges' reflections on the accident (D4), case archive (D5) and adjustment of emergency plan (D6); equipment and material support (E1), transportation support (E2), medical and health support (E3), communication information system support(E4), layout of emergency site (E5), formulation of normative documents (E6) and communication and coordination with society (E7).

4. TEST AND DETERMINATION OF THE EVALUATION INDEX SYSTEM OF PUBLIC EMERGENCY MANAGEMENT ABILITY

4.1 Preparation of the questionnaire

In order to test the availability and recognition of the preliminary evaluation index system for public emergency management capabilities in colleges and universities, the paper uses a questionnaire survey

method to get everyone's opinions on the preliminary evaluation index system for public emergency management capabilities in colleges and universities. The evaluation index system can be further corrected and modified.

According to the preliminary evaluation index system for the management ability of public emergencies in colleges and universities, the questionnaire was submitted to experts for review, and the areas with unclear semantics and unreasonable scores were modified. Based on the suggestions made by experts, the initially constructed evaluation index system for emergency management of public emergencies in colleges and universities was modified, and finally 4 first-level indicators and 23 second-level indicators were obtained and a questionnaire was constructed. A five-level scale was used to evaluate the variables. The subjects of the survey are required to evaluate various indicators based on their own understanding of emergency management in colleges and universities and their actual experience in handling public emergencies.

4.2 Distribution, collection and statistics of questionnaires

A total of 202 questionnaires were distributed in this survey, which were divided into 5 parts. The survey objects include university administrators, university emergency management college teachers, emergency management department staff, student counselors, school employees, and student representatives. Two questionnaires were removed (missing, over-filling, and all answers were consistent), and finally 200 valid questionnaires were obtained.

200 questionnaires of five level importance scale were collected and statistically analyzed. The data of 4 first level indicators and 23 second level indicators are shown in Fig. 3 to Fig. 7. Levels 1 to 5 in Fig. 3 to Fig. 7 are expressed as: 1-unimportant; 2 - a little important; 3 - important; 4 - more important; 5 - very important.
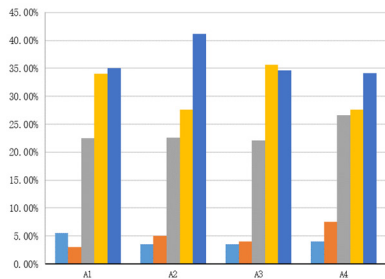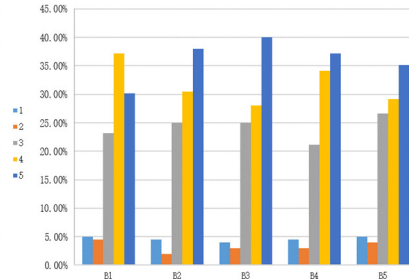
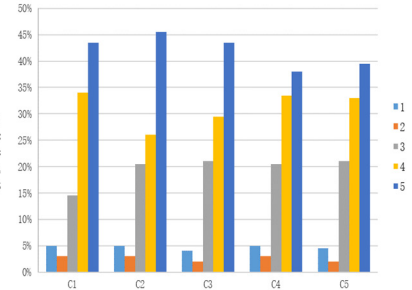

Figure 3. Data of A1-A4;

Figure 4. Data of B1-B5

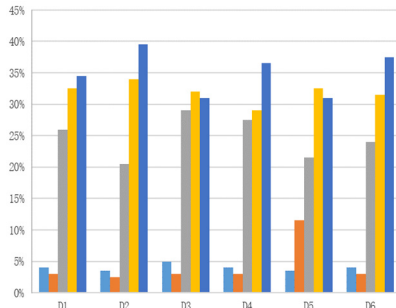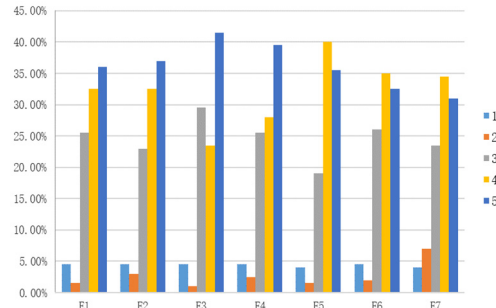Figure 5. Date of C1-C5

Figure 6. Date of D1-D6

Figure 7. Date of E1-E6

4.3 Theoretical basis of statistical model-Factor Model

The basic idea of this model is: adopt the corresponding statistical factor analysis model to extract important indicators reflecting the evaluation of the emergency management ability of public emergencies in colleges and universities from the existing questionnaires, and construct an evaluation index system for the emergency management ability of public emergencies in colleges and universities.

The factor model is set as:

$$x_1 = a_{11}f_1 + a_{12}f_2 + K + a_{1m}f_m + e_1$$
$$x_2 = a_{21}f_1 + a_{22}f_2 + K + a_{2m}f_m + e_2$$
$$\dots$$
$$x_p = a_{p1}f_1 + a_{p2}f_2 + K + a_{pm}f_m + e_p \qquad (1)$$

In the formula (1), f_1, f_2, K, f_m are the main factors, which respectively reflect the unobservable latent variables of a certain direction information: a_{ij} ($i = 1, 2, K, p$; $j = 1, 2, K, m$) is factor loading matrix. If a certain index plays a large role in a certain factor, the absolute

value of the factor's loading coefficient will be large, and vice versa; e_i, $(i = 1, 2, K, p)$ is a special factor, and is in actual modeling generally ignored.

5. STATISTICAL ANALYSIS OF QUESTIONNAIRE DATA BASED ON FACTOR MODEL

5.1 Reliability analysis

The paper uses the factor model to analyze the reliability of the questionnaire data, using the most commonly used Cronbach's α coefficient reliability method, and the results obtained after SPSS reliability analysis are shown in Tab. I.

TABLE I. RELIABILITY OF THE QUESTIONNAIRE

Test system	Cronbach's α coefficient
Overall reliability	0.984
Prevention ability	0.947
Handle ability	0.963
Recovery ability	0.954
Guarantee ability	0.975

It can be seen from the table that the overall α coefficient of the questionnaire in this paper is 0.984, and the reliability coefficients of the first-level indicators are also greater than 0.9. It can be seen that the overall reliability of the questionnaire is very good.

5.2 Validity analysis

Content validity analysis: The questionnaire in this article is summarized on the basis of a large number of references, and has been reviewed by experts and modified according to the experts' suggestions, which meets the requirements of content validity.

Structural validity analysis: Judge whether it meets the analysis requirements from KMO value and spherical Bartlett's test. If the index does not meet the standard, then the follow-up factor analysis cannot be performed.

After inputting the collected data into SPSS software, the KMO of the index system is 0.963, which is greater than 0.6, which meets the factor analysis conditions, indicating that it is suitable for factor analysis. The p value of spherical Bartlett test is 0.000<0.050, which can be used for factor analysis.

TABLE II.   VARIANCE EXPLANATION TABLE   UNIT: %

Variance interpretation rate table								
Factor number	Characteristic root			Rotation front difference interpretation rate			Variance interpretation rate after rotation		
	Characteristic root	Variance explained rate	accumulation	Characteristic root	Variance explained rate	accumulation	Characteristic root	Variance explained rate	accumulation
1	20.146	74.615	74.615	20.146	74.615	74.615	10.007	37.062	37.062
2	1.748	6.474	81.089	1.748	6.474	81.089	6.053	22.419	59.481
3	0.805	2.981	84.07	0.805	2.981	84.07	3.992	14.784	74.264
4	0.541	2.004	86.074	0.541	2.004	86.074	2.381	8.818	83.082
5	0.503	1.861	87.936	0.503	1.861	87.936	1.311	4.854	87.936
6	0.382	1.413	89.349	-	-	-	-	-	-
⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮
27	0.04	0.148	100	-	-	-	-	-	-

5.3 Factor analysis

The paper uses exploratory factor analysis (EFA) in SPSS to verify whether the options set according to the variables meet the initial model. The variance explanation rate table is shown in Tab. II. It can be seen that all indicators fall into 5 common factors. It can explain 87.936% of the total variation.   From Tab. II and the result of the component matrix after rotation for all indicators that through exploratory factor analysis, the evaluation index system of college emergency management capability falls into 5 factors respectively.

The four first-level indicators and the four second-level indicator sets corresponding to the four first-level indicators each correspond to a common factor. This result confirms the structure of the proposed index system, and also shows that the proposed questionnaire has high reliability and good structural validity.

5.4 Determination of the evaluation index for the emergency management ability of colleges and universities

Based on the expert suggestions and SPSS data analysis of the preliminary construction of the evaluation index system for the emergency management ability of public emergencies in colleges and universities, the paper examines and revises the preliminary construction of the evaluation index system, and finally determines the evaluation indexes of the emergency management ability of the colleges and universities public emergency management. The system is shown in Tab. III.

TABLE III.   THE FINAL EVALUATION INDEX SYSTEM OF THE EMERGENCY MANAGEMENT ABILITY OF COLLEGES AND UNIVERSITIES

First level indicators	Second level indicators
A1	B1-B2-B3-B4-B5
A2	C1-C2-C3-C4-C5
A3	D1-D2-D3-D4-D5-D6
A4	E1-E2-E3-E4-E5-E6-E7

6. CONCLUSIONS

(1) Based on big data and IOT technology, a comprehensive emergency management platform and communication network system in colleges and universities are planned and constructed.

(2) Combined with the factor model, the evaluation system is tested and revised by using the statistical analysis method, and finally, the evaluation index system of public emergency management ability in colleges and universities is established.

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