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AN ASSESSMENT ON MATURITY OF UNIVERSITY EMERGENCY MANAGEMENT IN CHINA

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Abstract. In this study, we assess the maturity of university emergency management and the resilience closely related to it. Firstly, to find out the weak links of university emergency management, this study takes Hanshan Normal University as the case, and adopts SPSS and 2-tuple linguistic information to assess the survey indicators. Secondly, on the basis of in-depth cause analysis, this study combs the essential characteristics of resilience, and obtains the implications of university education. The current study implies that the best process of university resilience is the combination of the ability to actively resist the impact by constantly anticipating and preparing before the occurrence of a destructive event, and to quickly respond, adapt and learn under the impact of a destructive event.

1. Introduction

Since the 21st century, China and the world have faced more and more public emergencies, such as SARS virus (occurred in 2002), Wenchuan earthquake (in 2008), Yushu earthquake (in 2010), and the novel COVID-19 that shocked the whole country and the world at the beginning of 2020. These events are also refreshing people's understanding of emergencies, and also deepening people's understanding of emergency management of emergencies.

In recent years, with the continuous development of the network era and economy, the internal and external environment faced by colleges and universities is constantly changing, and the psychology, thoughts, and concepts of college students are changing. Therefore, higher education should pay more attention to the all-round education and guidance of students. Unsafe factors and challenges faced by universities are getting bigger and bigger. In the past decade, university emergencies have occurred frequently, such as the Ma Jiajue incident (occurred in 2004), Yao Jiaxin incident (in 2010), my father's being Li Gang incident (in 2010), jumping from buildings incident (in 2021) and various suicide incidents, making universities a gathering place for emergencies. The occurrence of these incidents not only seriously affected social stability and the stability of universities, but also seriously affected the mental health and personal safety of students, caused huge adverse effects and

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economic losses to the society, and also brought irreparable and devastating pain to individual families.

University emergency management has increasingly attracted the attention of all sectors of society. China has established a management system of "one case, three systems" for emergencies. As early as 2007, China promulgated the Emergency Response Law of the People's Republic of China. These laws, regulations and rules also provide institutional guidance and methods for China's universities to deal with emergencies. Universities should pay more attention to the problems in their internal management and the psychological health of student groups, actively establish emergency plans and handling systems, properly handle and solve emergencies in universities, and enhance the prevention and response capabilities of college emergencies. Based on this background, this study selected one university in Guangdong Province, China as the research object to assess the prevention and handling of university emergencies, and analyze the maturity level of its emergency response capability. The study results are expected to further improve the current situation of emergency management, and also have a certain significance for the establishment and improvement of emergency management system in other universities.

2. Literature review

Western countries first concerned about university emergencies at the end of the last century, when the United States introduced the University Safety Act of 1990, and the Practical Guide to University Crisis Response, highlighting that university emergencies have stepped onto the stage of history [6]. From the end of the 20th century to the beginning of the 21st century, foreign scholars put forward many classical theories on university emergencies, the most representative of which is Fink's four stage life cycle model. This theory has played a very important role in effectively solving university conflicts, dealing with university emergencies, and maintaining university safety and harmony. It also laid a systematic theoretical foundation for academic research on university emergency management [9]. After the September 11th incident in the United States in 2001, university safety has also become the focus of attention of universities and the society, and the protection of students' physical and mental safety has become another major issue. Smith [18] pointed out that the solution and handling of university crisis should also become a social issue. Korfiati et al., [14] thought that education 4.0 ecosystems must be used to enhance the skills and competences of both students and manufacturing employees of the new era. Kröll et al., [15] identified a solution approach for promoting both individual and organizational competencies. Stavropoulos et al., [19] strengthened education 4.0 and Smart Learning ecosystems. Andreea & Cristian [1] argued that universities still faced challenges that affect students' healthy learning. Svetec & Divjak [20] pointed out that factors that affected the response of the education system include readiness for change. Walter & Pyżalski [22] conducted a coherence analysis of the digital capabilities of European educators. Tušer [7,8,21] systematically sorted out the development of emergency management, and based on this, analyzed the reasons for the positive and negative aspects of the concept of education.

Chinese scholars started their research on college emergency management later than western countries. In the 1990s, the concept of emergency management was proposed, and the focus of emergency management in different periods was different. Zhou [24], in his article "China's Educational Crisis", put forward a clear idea of university emergencies, which is the first time that the research on university emergency management in China has been clearly proposed, and formed a certain theoretical basis in his article. This theoretical basis has also become an important reference for later scholars to study university emergencies. In 2003, research on emergency management based on natural disasters became the main research content of this period [23].

In conclusion, the current study on this subject has not yet formed a mature system. In order to finally explore the application technology and assessment method system that can effectively and comprehensively guide the practice of emergency response in universities in China, more innovative or a lot of detailed improvement work may be required. In the context of the increasing attention paid to the emergency response of universities in China, the assessment study on the maturity of the emergency management capability of universities should be launched in due time to demonstrate its internal and external processes around the emergency identification, assessment and control, emergency exercise system, and the coordination and control of interested parties, which are closely related to the emergency response of universities in China, it is necessary and urgent to take modeling and assessment as the main line to present the maturity of university emergency response in China.

3. Measurement methodology and data

3.1. **Indicator System Construction.** According to emergency management theory, crisis life cycle theory, ISO45001:218 occupational health and safety management system theory and capability maturity model theory, and after integrating Bao et al. Chen, Healther et al., Kerzner, Klein et al., [2,5,7,12,13] and other documents on university emergency management assessment methods and strategies, it is proposed to construct the maturity assessment indicator system of university emergency management ability from the perspective of safety system management ability, etc. as shown in Table 1.

Table 1: Maturity Assessment Indicator of University Emergency Management Ability

U_1 Safety system management capability	U_{11} Ability to build public safety system
	U_{12} Ability of safety management rules and regulations plan
	U_{13} Emergency rescue capability of safety personnel
U_2 Public safety material guarantee capability	U_{21} University monitoring and early warning facilities
	U_{22} Emergency management ability of university fire and explosion prevention measures
	U_{23} Guard room emergency management capability

	U_{24} Emergency prevention ability of university road traffic accidents U_{25} University anti-theft emergency management ability U_{26} Canteen sanitation and food safety emergency management capability
U_3 Public safety spirit guarantee ability	U_{31} Ability to build university safety culture U_{32} University safety and environment guarantee ability U_{33} Ability to build university safety atmosphere U_{34} Ability to establish psychological and spiritual counseling institutions
U_4 Safety education ability	U_{41} Ability to publicize and train safety knowledge U_{42} Emergency knowledge training ability U_{43} Emergency training popularization ability U_{44} Interactive ability of online teaching
U_5 Post improvement capability assessment	U_{51} Post investigation and assessment capability U_{52} Timely rectification ability U_{53} Emergency plan drilling capability U_{54} Emergency plan updating capability
U_6 Ability to interact with interested parties	U_{61} Ability of fire and explosion prevention linkage mechanism with the fire department university U_{62} Ability of joint prevention mechanism with food hygiene supervision bureau canteen U_{63} Ability of joint mechanism with university safety of the Public Security Bureau U_{64} Cooperate with parents, enterprises and nearby universities to develop innovative mechanism capabilities

3.2. **2-tuple Linguistic Information Method Integrating CMM Hierarchical Features.** Capability Maturity Model (CMM) is a guiding model for software process improvement produced by the Software Engineering Research Institute of Carnegie Mellon University in the United States, which gathers the experience and wisdom of software process managers from all over the world. Its core idea is to find and improve weak links by assessing the maturity of organizational processes, so as to form a continuous improvement model. This study introduces CMM to assess and analyze the emergency management capability of universities. The model divides the capability maturity into five levels as shown in Table 2 [17]. In order to solve the problem of information loss caused by language information operation or

processing, this study adopts the method of describing language assessment information with 2-tuple linguistic to effectively avoid information loss and distortion in language assessment information aggregation and operation [9,2,3].

TABLE 2. Classification of Emergency Capability Maturity Level Characteristics

Level	Characteristic
S1 Initial Level	The emergency management process is disordered or even chaotic. The definition of emergency management process is almost in a state of no rules and steps to follow. The emergency decision-making process often depends on the efforts and opportunities of individuals, and lacks the concept of time.
S2 Repeatable Level	A basic emergency management process has been established. The progress and status of emergency management process can be defined. It has rules to follow and can repeat the past successes. And it can complete the emergency management process in a limited time.
S3 Defined Level	The emergency decision-making process adopts a standardized process. The processes have been documented and standardized, and a standard emergency process has been formed. It also has strong time control ability.
S4 Managed Level	Each process of emergency management has been quantitatively recognized and controlled. Each management work is based on quantitative analysis and has a relatively stable management model. It can quantitatively measure the time allocation of the corresponding process.
S5 Optimization Level	The process can be continuously improved. All kinds of useful information from processes, new concepts and new technologies can be analyzed quantitatively, and the improvement can be carried out continuously and effectively. It can continuously and dynamically control and adjust the decision-making time.

2-tuple linguistic and its aggregation operator were first proposed by Spanish scholar Herrera in 2000, 2-tuple linguistic information refers to the assessment results given for a target (or object, criterion) expressed by 2-tuple group (s_k, a_k) , and the meanings of the elements s_k and a_k are described as follows [9,2,3].

(1) s_k is the k^{th} element in the predefined language assessment set S, which represents the language phrase closest to the given or obtained language assessment and the initial language assessment set, and the language assessment set can be expressed as

$$\begin{aligned} S &= \{s_0, s_1, s_2, s_3, s_4\} \\ &= \left\{ \begin{array}{l} InitialLevel, RepeatableLevel, DefinedLevel, \\ ManagedLevel, OptimizationLevel \end{array} \right\} \end{aligned} \tag{3.1}$$

And, according to the evaluation of 2-tuple linguistic information, the evaluation indicator is divided into six grades, as shown in Table 3.

TABLE 3. Grading instruction

Semantic Identity	Semantic Grade	Assessment Score	Grading Instruction
S_0	I	60 below	Initial level
S_1	R	60-70	Repeatable level
S_2	D	70-80	Defined level
S_3	M	80-90	Managed level
S_4	O	90-100	Optimization level

(2) a_k is called the sign transfer value, and satisfies $a_k \in [-0.5, 0.5)$, which represents the deviation between the assessment result and s_k.

The following are the definitions and operations of 2-tuple linguistic:

Definition 3.1. If $s_k \in S$ is a language phrase, the corresponding 2-tuple linguistic form can pass through the linear function θ

$$\begin{aligned} &\theta : S \to S \times [-0.5, 0.5) \\ &\theta(s_k) = (s_k, 0), s_k \in S \end{aligned} \tag{3.2}$$

Definition 3.2. Let the real number $\beta \in [0, T]$ be the real number obtained from the language assessment set S by aggregation method, where T is the number of elements in the language assessment set S, then β It can be expressed as 2-tuple linguistic information by the following function Δ

$$\Delta(\beta) = \left\{ \begin{array}{l} s_k, k = round(\beta) \\ a_k = \beta - k, a_k \in [-0.5, 0.5) \end{array} \right\} \tag{3.3}$$

where *round* means the rounding operator.

Definition 3.3. Let (s_k, a_k)be a 2-tuple linguistic, where s_k is the k^{th} element in S, $a_k \in [-0.5, 0.5)$, then there is an inverse function Δ^{-1}, which is converted to the corresponding numerical value $\beta \in [0, T]$

$$\Delta^{-1}(s_k, a_k) = k + a_k = \beta \tag{3.4}$$

Definition 3.4. Let $\{(s_1, a_1), (s_2, a_2), ..., (s_m, a_m)\}$ be a set of 2-tuple linguistic information and $W = ((w_1, \beta_1), (w_2, \beta_2), ..., (w_m, \beta_m))$ be the corresponding 2-tuple linguistic weight vector, then the weighted arithmetic operator based on 2-tuple linguistic is defined as

$$\left(\bar{s}, \bar{a}\right) = \Phi((s_1, a_1), (s_2, a_2), ..., (s_m, a_m)) = \Delta\left(\sum_{i=1}^{m} c_i w_i\right), \bar{s} \in S, \bar{a} \in [-0.5, 0.5) \tag{3.5}$$

where, the c_i element represents the i^{th} element in $\left\{\Delta^{-1}(s_k, a_k), k = 1, 2, ..., m\right\}$.

3.3. **Data Acquisition.** In order to assess the maturity of university emergency management, Hanshan Normal University (HNU) in Guangdong Province of China is selected as a case for assessment. It is a undergraduate normal university with a long history and distinctive characteristics in Guangdong Province, which is located in Chaozhou City, a famous cultural city with national history and reputation of "China's Ceramic Capital". The campus is close to mountains and rivers, with complete facilities, and is an ideal garden for studying, working and living. The school covers an area of 740000 square meters and a building area of 470000 square meters. It has 16 teaching institutions and 57 undergraduate majors and enrolls students from 16 provinces (districts). To obtain the data related to the assessment of the maturity of emergency management of HNU, according to the definition of assessment indicators and 2-tuple linguistic information, 120 relevant personnel from the medical industry (20 people), the Prevention and Control Office (20 people), enterprises (10 people), university logistics management personnel (20 people), university teachers (25 people), university students (20 people), parents (5 people) were invited to conduct a questionnaire survey and online and offline interviews in the past two years[1]. All personnel have participated in the management of the epidemic process, ensuring the representativeness of the questionnaire sample. To ensure the validity of the questionnaire, 5 invalid questionnaires were excluded. And the reliability and validity of the questionnaire were verified using SPSS 28 software, and the verification results showed that Cronbach α (0.910) indicates that the questionnaire distributed is reliable. After further validity verification through KMO and Bartlett tests, the conclusion is that KMO>0.8 and the significance coefficient is less than 0.001. This value shows that the variables are valid and the correlation between variables is significant, indicating that the questionnaire can be further modeled and analyzed.

4. Measurement results

According to definition (2-4), β value of U_{11} can be calculated:

$$(\bar{s}, \bar{a}) = \Phi((s_1, a_1), (s_2, a_2), ..., (s_{102}, a_{102})) = \Delta(\sum_{i=1}^{102}) = 2.81 \tag{4.1}$$

According to the definition (2-4), the 2-tuple linguistic information of U_{11} after aggregation can be calculated as $(S_3, -0.19)$. Similarly, according to definition (2-4), β value of U_1 can be calculated:

$$\begin{aligned} (\bar{s_{11}}, \bar{a_{11}}) &= \Phi((s_{11}, a_{11}), (s_{12}, a_{12}), (s_{13}, a_{13})) \\ &= \Delta(\sum_{i=1}^{3}) = \Delta\left((0.293 \times 2.81) + (0.332 \times 2.54) + (0.375 \times 2.71)\right) \\ &= 2.68 \end{aligned} \tag{4.2}$$

According to the definition (2-4), the 2-tuple linguistic information of U1 after aggregation can be calculated as $(S_3, -0.32)$. Similarly, β value and 2-tuple linguistic information of other indicators can also be obtained as shown in Table 4.

[1]The link for the survey questionnaire is: `https://www.wjx.cn/vm/Qkf7TH2.aspx#`

TABLE 4. Summary of weight value and 2-Tuple Linguistic Information of one-level indicators

Indicator	Weight	β value	2-Tuple Linguistic Information
U1	0.201	2.68	$(S_3, -0.32)$
U2	0.187	2.91	$(S_3, -0.09)$
U3	0.103	2.43	$(S_2, 0.43)$
U4	0.178	2.58	$(S_3, -0.42)$
U5	0.202	2.75	$(S_3, -0.25)$
U6	0.129	2.63	$(S_3, -0.37)$

And the 2-tuple linguistic information of the university can be obtained as $U = 2.64(S_3, -0.36)$.

In summary, the assessment results of 2-tuple linguistic information show that:

The membership of U_{25} (canteen sanitation and food safety emergency management capability), U_{31} (ability to build university safety culture), U_{44} (interactive ability of online teaching), U_{51} (post investigation and assessment capability), and U_{64} (cooperate with parents, enterprises and nearby universities to develop innovative mechanism capabilities) belong to Repeatable Level, the membership of U_{12} (ability of safety management rules and regulations plan) and U_{43} (emergency training popularization ability) are close to Repeatable Level, the membership of U_{42} (emergency knowledge training ability) belongs to Management Level, and others belong to Defined Level.

5. Implication and conclusion

The results of the 2-tuple linguistic information assessment of this study found that the way for universities to deal with emergency management is to improve the university resilience, through sorting out the connotation, theory, process model and future education of resilience, and based on the assessment results it can be drawn the following implications for universities:

In the face of unstable, uncertain and complex social safety problems, schools simply relying on the teaching of safety knowledge is not enough to support students to effectively deal with safety problems in real situations. The Adaptive Cycle theory emphasizes that when encountering danger, individuals can calm down and rebound after encountering setbacks. Therefore, school safety education should also cultivate and develop students' corresponding abilities, among which social emotional abilities are indispensable. These social emotions are embodied in the ability to achieve goals, including abilities of persistence, self-control, passion to achieve goals, cooperation with others, including abilities of social, respect, care, emotion management, including abilities of self-esteem, optimism, self-confidence, and emphasis on self-improvement and caring for others. The students themselves are vulnerable. Bringing the cultivation of social emotional ability into the scope of school safety education, so that students can pay attention to their own and others' physical and psychological safety, is the most basic content of school safety education, which is conducive to the formation of anti-vulnerability resultant force.

Although this study has made some contributions, due to the multi-level, multi-dimensional and dynamic characteristics of resilience, its quantitative assessment is still facing great challenges. Resilience theory has been developing continuously in the past two decades, but empirical research has been rare, especially in the assessment of university resilience, which refers to the potential ability of an organization to predict, avoid, and adjust to environmental impacts. The measurement method of organizational resilience is still in the exploration stage. Whether it is based on organizational capability characteristics or organizational results, it ignores the dynamic and multi-level characteristics of organizational resilience, organizations should proactively anticipate potential threats and develop detailed defense plans in advance, and enhance their ability to quickly respond, adapt, and learn [4]. Starting from the level of universities, it is necessary to integrate time variables and space variables into the university resilience measurement model. In the university response process, a multi-level assessment method combining qualitative and quantitative methods can be used to promote the empirical study of university resilience, so as to ensure the effectiveness and systematicity of university resilience assessment.

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