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Investigation and analysis of the importance awareness of the factors affecting the earthquake emergency and rescue in different areas: A case study of Yunnan and Jiangsu Provinces

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ABSTRACT

An index system comprising four primary indicators and 47 secondary indicators was constructed for earthquake emergency and rescue, based on recent earthquake disaster relief cases, relevant Chinese policies and regulations, and recent literature. Using a questionnaire survey and the Analytic Hierarchy Process (AHP), then an investigation method was designed to determine the importance awareness of the factors affecting the earthquake emergency and rescue. Finally, by performing a case study of two areas in China, i.e., Yunnan and Jiangsu, the similarities and differences in the importance awareness of the factors affecting the earthquake emergency and rescue in different regions were investigated and analysed. The understanding of the importance of the highest ranked factors was nearly similar, and the ranked order of the most important factors was highly consistent. However, obvious differences were observed in the understanding of the importance of certain factors. The understanding of the "basic environmental background", which is a first-level index, and 10 s-level index factors (e.g., industrial hazards control level, topographic relief, lithology, depositional conditions and climatic conditions) were significantly different.

1. Introduction

Earthquakes are the most destructive natural hazards worldwide, and their potential damage has significantly increased [1]. Due to their unpredictable nature, earthquakes are among the most lethal natural hazards, as observed in China (2008), Haiti (2009), and Japan (2011) [2]. China is frequently affected by earthquakes that have the potential to cause devastating effects across most of its territory. Since 1900, approximately 800 earthquakes with surface-wave magnitudes (Ms) over 6.0 have occurred. More than 550,000 people have died from these earthquakes, accounting for 53% of the world's earthquake-related deaths during this period [3]. Researchers have devoted considerable attention to the evaluation of earthquake emergency and rescue capabilities, which are critical for emergency preparedness and building capacity. Studying the composition of earthquake emergency rescue factors and understanding their importance are the basis of capacity evaluations. Recently, researchers have focused on the indicators of earthquake emergency response and evaluation models. For example, Cutter et al. [4] established disaster resilience evaluation models at various levels, including the national, regional and community levels. Ainnuddin and Routray [5,6] established an evaluation index

system of community resilience in the context of seismic hazards in Baluchistan, Pakistan. This system comprised four first-level indexes, including social, economic, institutional, and physical indexes, and 15 s-level indexes. Bruneau et al. [7] developed a framework that included engineering technology, organization and management, and social and economic aspects to quantitatively assess and enhance the seismic resilience of communities. Nie et al. [8] established a model including three categories of indexes, i.e., earthquake emergency capability, emergency assessment and decision-making, and emergency zoning. These authors explained the connotation, form of expression and source of each index. Based on a field investigation of the "5-12" Wenchuan earthquake, Deng et al. [9] constructed an evaluation index system of earthquake emergency response capacity at the county level that comprised 1 target layer, 5 criteria layers and 17 indicators. Deng et al. [10] proposed a set of models of emergency rescue influencing factors for various counties in China that comprised 4 first-level and 47 s-level indicators. Based on the Chinese emergency rescue plan, Li et al. [11] proposed an evaluation index system of earthquake emergency capability that comprised 5 first-level indexes and 19 s-level indexes. Using provincial administrative units as examples, the specific meanings and calculation method were presented. Li et al. [12]

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established a model for the assessment of the ability to reduce the impact of regional earthquakes.

According to the abovementioned studies, the factors that affect earthquake emergency rescue include natural, social, economic, engineering and management factors. This has been the consensus in academic circles. However, which of these factors are more important? What are the key factors for capacity building? Identifying the differences among the various influencing factors is important for establishing capability evaluation models and determining the mechanism of the influencing factors [4].

The field of disaster perception is concerned with the importance awareness of influencing factors. According to social scientists specializing in social perception, people's perceptions or understanding of natural disasters is socially constructed [13]. Social perception is important because it enables people to understand and interact with the physical and social world. Renn et al. [14] indicated that an understanding of how people perceive natural hazards should consider the context in which the natural hazards are experienced. The context may include unique geographical, socio-economic and cultural factors, direct and indirect experiences, and political characteristics that influence the formation of a community's perception of risk. [15–18]. For example, Ho et al. [19] demonstrated that victims' (mostly rural dwellers) perceptions of the risk associated with floods and landslides differed from the perceptions of the general population (mostly urban dwellers) in Taiwan. The victims have been previously directly exposed to floods and landslides and thus perceive these events as more threatening than the general population, whose exposure to these hazards is limited. In addition, female victims considered the natural hazards riskier than their male counterparts because these events greatly affected their domestic activities. Boholm [20] posited that culture is crucial to social perceptions of risk and natural hazards. For example, among the Hima tribal group, which is a Bantu-speaking group in southwestern Uganda, women are expected to avoid contacting cattle because of the belief that such contact could cause death and sickness among the cattle. Sherry Adomah Bempah et al. [18] discussed the unique socio-cultural factors that shaped flood victims' perceptions of the causes of floods in their communities in Ghana. Syed Ainuddin et al. [5] discussed the differences in the understanding of the importance of community resilience indicators between Pakistan, which is a developing country, and America, which is a developed country. Gao et al. [21] conducted face-to-face interviews to determine the differences in the importance awareness of capability indicators among three different groups (i.e., researchers, heads of management and general clerks) in Tangshan, China. Significant differences were observed among the different groups in the understanding of the importance of the indicators. Earlier researchers exploring human behaviour emphasized a link between people's perceptions and their behaviour. Pennings et al. [22] concluded that risk perception is the primary driver of citizens' actions and, hence, a good source of information for determining behavioural outcome space (BOS). Policymakers rely on BOS in making major decisions regarding disaster situations. Perceptions influence behavioural responses to mitigation strategies in environmental hazard-related disaster management [14,23]. Currently, international disaster management efforts emphasize the identification and targeting of differing perceptions prior to implementing any disaster risk reduction project in a community [18]. Although many studies have explored disaster perception, few studies have focused on the importance awareness of the factors influencing the earthquake emergency and rescue in different regions.

Determining the index weight is a quantitative method in cognitive analyses. The current methods used to determine the index weight include empirical analyses and subjective evaluations [11,12,24–28]. The expert scoring method is a primary subjective method used to determine the index weight. For example, Cutter et al. [29] developed an empirical weight evaluation system. Syed Ainuddin et al. [5] proposed the weights scale scoring method. The Analytic Hierarchy Process

(AHP), which was developed by Saaty, who was a professor at the University of Pittsburgh in the 1970s, is a methodological approach for decision-making that can be applied to solve highly complex problems involving multiple scenarios, criteria, and actors [28]. This approach is valuable in analysing human cognition to determine the relative importance of a collection of alternatives using paired comparisons [30] and has been used in various studies that sought to enhance development in different sectors, such as tourism [31], environmental and natural resources [32], forestry [33], coastal management [34], and disaster and risk management [10,35,36].

Due to the diverse backgrounds, the cognition of importance clearly differs across different regions. China is vast in territory. The natural geography, seismic activity, economy, and social and cultural conditions in different regions create obvious regional differences. People who live in different regions, particularly managers engaged in earthquake emergency responses and researchers providing decision support for emergency management, certainly display similarities and differences in their awareness of the importance of the factors affecting earthquake emergencies. Studies exploring these differences are required to achieve an in-depth understanding of the importance awareness of the factors affecting earthquake emergency and rescue in different areas. A scientifically based system involving indicators and region-targeted recommendations that considers cognition must be established.

This study examines the similarities and differences in the cognitions regarding the factors affecting the earthquake emergency and rescue between Yunnan and Jiangsu, China, using a survey questionnaire and the AHP method. This paper focuses on the following three main points: (1) building an index system of the factors influencing earthquake emergency and rescue, (2) designing an investigation and analysis method to examine the importance awareness of the factors affecting earthquake emergency and rescue, and (3) discussing the cognitive similarities and differences between two different regions and the primary reasons underlying these similarities and differences.

2. Index system of earthquake emergency and rescue

2.1. Index system based on AHP

Disaster emergency and rescue is a component of disaster resilience [29]. Resilience is a multifaceted concept that includes infrastructural, social, economic, institutional, ecological, and community elements [7,29,37–39]. Resilience is also a multi-level concept that includes countries, regions, cities, counties and communities. In China, the county system has occupied a special place in the Chinese administrative division system for more than two thousand years. County governments are the most basic administrative units in China, are direct policy executors and have a relative sense of power. Therefore, a study based on the county level is more attuned to the actual needs of emergency management in China. However, no single method or a set of standardized indicators to measure resilience is available [4]. A standardized index system of earthquake emergency and rescue is also lacking.

In this paper, we carefully selected indicators based on a theoretical analysis, recent earthquake disaster relief cases, relevant Chinese policies and regulations, and recent literature. The National Earthquake Emergency Plan is a core regulation that clearly entailed key safeguard measures; these measures are the same factors that affect an emergency [40]. This study proposed an index system using the AHP; the problem was deconstructed into several specific problems, and a hierarchical structure model was established. Then, the relative importance of each element in the model was assigned a quantitative expression based on a judgement of its objective reality [41]. In this study, the components affecting earthquake emergency and rescue are presented in a three-tiered hierarchy representing the relevant aspects of an AHP model. The top tier represents a goal related to the problem; the second tier

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