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Assessment of the Resilience of Schools to Disasters in Kermanshah, Iran in 2020

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A B S T R A C T

Background: The effort to reduce harm by adopting risk reduction strategies to establish a safe environment is known as school resilience to disasters. Resilient schools have a good capacity in disasters and their educational mission. Following natural disasters, schools play a critical role in the recovery of society. The study aims to assess the resilience of schools to disasters in Kermanshah, Iran.
Methods : This research is a cross-sectional descriptive-analytical study. A proportionate stratified random sampling strategy was used to select 231 participants from schools in Kermanshah. Total resilience showed the weakest (r = 0.499) and strongest (r = 0.910) correlations with location and function. Data were collected using standard school resilience in disasters questionnaire and analyzed using SPSS version 22. Statistical tests such as Pearson correlation, independent t-test, and one-way ANOVA were conducted at a significant level of 0.05.
Results : The results showed the X ± SD of the total resilience score (143.61±32.50). The highest and lowest mean scores among the resilience dimensions were assigned to function (43.81± 13.11) and safety (6.59± 3.40) dimensions, respectively. In addition, there was a significant positive correlation between total resilience and its dimensions (*P* <0.001). Total resilience showed the weakest (r = 0.499) and strongest (r = 0.910) correlations with location and function dimensions.
Conclusion : The level of school resilience was determined to be moderate. It can assist the schools' management board in analyzing the schools' level of resilience and setting disaster risk reduction priorities. Awareness of the resilience state can aid policymakers and professionals in developing an effective resilience program.

1. Introduction

Communities and individuals are becoming increasingly vulnerable, and perils are on the rise [1]. Throughout history, disasters have always left adverse impacts on human life. More than 1.1 million people were killed worldwide, and more than $ 138 billion was lost in natural disasters between 2000-2011 [2]. One of the consequences of disasters is destruction and damage to schools [3]. The Sichuan earthquake in 2008 killed 19,000 students and destroyed about 7,000 schools [4]. According to studies on the renovation and equipment of Iranian schools, about 65% of schools are not earthquake resistant. Given that schools are

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built in different locations and concerning their vital role in the aftermath of disasters, they are considered a shelter for homeless people and a place for health services and other emergency operations [5]. The Sendai framework for safe schools, effective disaster management, disaster risk reduction, and resilience education was outlined at the Third International Conference on Disaster Risk Reduction in Japan in 2015 and is considered a comprehensive school safety [6]. Therefore, there are two types of disaster coping strategies: predictive and resilience. The former deals with known problems and dilemmas, and the latter deals with unknown difficulties [2]. Resilience is defined as the ability to "withstand a crisis" or "return to the original state after a crisis" [7]. Focusing on resilience in the cities and vulnerable places such as schools is necessary besides introducing effective solutions [4]. The Hugo Document (2005-2015) and the Sendai Framework (2030-2015), as upper-hand documents, connect the topics of school structure, non-structural, managerial, human resources, education, staff, and students. Therefore, preparing them against catastrophes is of paramount importance [7]. It is also important for principals and policymakers to recognize the effective components of school resilience and develop a comprehensive plan to prepare schools against disasters [5]. Earthquakes are also considered one of the natural disasters that cause damage due to their destructive effects throughout human history [8]. Iran is located in an earthquake-prone area along the Alpine-Himalayan orogenic belt. Throughout its history, this country has suffered many devastating earthquakes, including Sarpol-e Zahab in Kermanshah province in 2017, known to be the most devastating recent incident in Iran [9]. Accordingly, Kermanshah falls under the relatively high damage area where earthquakes as strong as 6 magnitudes are likely to happen [10]. Consequently, preparing schools is crucial to devise specialized programs to address specific challenges and critical situations [6]. Studies on school resilience have focused more on the pre-disaster and post-disaster roles of schools and have examined whether there are disaster preparedness programs or not. However, school resilience takes into account various components. Therefore this study aimed to determine the resilience of schools in Kermanshah during disasters.

2. Materials and Methods

The study is a descriptive-analytical, cross-sectional study conducted in 2020 in Kermanshah schools. Sampling was done by a simple random method proportional to size. First, the sample size was determined using the equation (Eq1). The estimate's required accuracy (d) was set at 0.05, with an abundance ratio of 50% and a confidence interval of 95%. The sample size was obtained to be 231 schools using the Eq1.

Eq1: $n = \frac{Nz^2pq}{N\,d^2+z^2pq}$

Then, in proportion to the number of schools covered in each education district, the sample size of each district was determined. Thus, from district one 80, district two 54, and district three 97 schools were randomly selected. Then, one of the knowledgeable staff members of the school, including the school principal, deputy principal, or teachers, was asked to complete the questionnaire after explaining the objectives of the study and obtaining informed consent. Schools that were unwilling to participate in the study were replaced with new ones randomly. All urban schools for girls and boys, governmental and non-profit at three levels (elementary/first and second high school) were included in the study. Kindergartens and preschools were excluded from the study. The data were collected by the school resilience in disasters questionnaire, designed and validated by Mirzaei et al. (2020) with adequate internal consistency Cronbach's (α =0.95) [4]. The questionnaire consists of two parts: the first part of the questionnaire measuring the resilience of schools in disasters with 48 items that measure the dimensions of school location (3 items), structural (3 items), non-structural (3 items), architecture (5 items), commute routes (4 items), equipment (3 items), safety (3 items), education (8 items), and function (16 items) of school resilience. The range of answers to the questions is a 5-point Likert scale (very high = 5 to very low = 1). The score of each dimension was obtained separately by summing the scores of its items, and the total resilience score was calculated by adding the dimensions' scores. Higher scores indicate better resilience in school. The second part included questions about construction year, surface (area), number of classes, type (primary/first period of high school/second period of high school, students' gender, and governmental or non for profit), and manager's work experience of schools. After providing sufficient information about the study for all participants, they were asked to sign a written consent form. The data analysis was performed using the statistical software for the SPSS version 22 (SPSS Inc., Chicago, IL, IL, USA). Parametric tests were used according to the kurtosis and skewness [11]. Pearson's correlation coefficient was used to measure the linear relationship between variables. The strength of the correlation was interpreted based on Cohen's (1988) guideline. Thus, the 'r' from 0.10–0.29 was considered a weak correlation, the 'r' from 0.30 – 0.49 as medium correlation, and the 'r' from 0.50–1.00 as a strong correlation [12]. In order to compare the resilience mean score of schools based on their characteristics, we used the independent t-test and one-way ANOVA.

3. Results and Discussion

Assessing 231 schools' resilience against natural disasters in Kermanshah showed the X ±SD age of the participants was 46± 6 years, and the mean work experience of the participants was 24± 7 years. 125 (54.55%) participants were women, and 129 (55%) had a bachelor's degree. Regarding the job category, 124 participants (53%) worked in managerial positions. Also, 218 (94%) participants had experienced disasters before. The X ±SD total score of school resilience in disasters was 143.61±32.50. Participants had the highest and lowest mean score in function and safety dimensions, respectively (Table 1).

Table 1: Mean and standard deviation of school resilience in disasters

Dimensions of school resilience in disasters	X ± SD	MIN – MAX[1]	Range scale[2]
Location	10.70±2.58	3-15	3-15
Structural	8.92±3.12	3-15	3-15
Non-structural	10.54±2.41	3-15	3-15
Architecture	19.54±3.93	7-25	5-25
Commute routes	10.00±3.71	4-20	4-20
Equipment	11.23±2.97	3-15	3-15
Safety	6.59±3.40	3-15	3-15
Education	22.15±7.79	8-40	8-40
Function	43.81±13.11	17-79	16-80
Total resilience	143.61±32.50	74-221	48-240

*SD, Standard deviation
[1] The obtained lowest and highest values in this study.
[2] The lowest and highest values can be obtained in the original scale.

Table 2 shows the results of the correlation analysis between the total score of resilience and its dimensions. The strongest correction was observed between the function dimension and total resilience (r=0.91, *P*=0.001). All dimensions had a strong and positive correlation with total resilience, except for the location dimension, which had a moderate correlation with total resilience (r= 0.49).

Table 2: Pearson correlation analysis of school resilience components in disasters

Dimensions of resilience	R	P-value
Location	0.499	
Structural	0.645	
Non-structural	0.727	
Architecture	0.591	
Commute routes	0.653	**<0.001**
Equipment	0.647	
Safety	0.666	
Education	0.874	
Function	**0.910**	

*r, Correlation between dimensions and total resilience

This study also compared resilience scores in terms of school characteristics. The independent t-test showed that non-for-profit schools and those who experienced disasters had higher resilience scores. The difference was statistically significant. Findings of the ANOVA test depicting mean resilience score in terms of structural characteristics showed that there is a significant difference between groups in terms of construction material (*p* <0.009) and also the type of school structure (*p* <0.008). Additionally, the Bonferroni post hoc test results indicated that the mean resilience score in soft soil schools is lower than in other groups. Principals who completed the questionnaire and those with a master′s degree had a higher resilience score. (Table 3).

Table 3: Comparison of mean school disaster resilience in Kermanshah in terms of school characteristics

Variable		X ± S.D	P-value
Type of school	Government	141.82±31.33	0.002*
	Non for profit	167.75±39.85	
Disasters experience	Yes	146.21±31.73	0.006*
	No	130.44±33.58	
Ground construction material	Stone	149.03±30.92	0.009**
	Rocky soil	143.50±32.29	
	Soft soil	129.40±33.82	
Type of school structure	Concrete skeletal	150.89±31.15	0.008**
	Steel structure	145.95±32.00	
	Masonry	134.29±33.62	
Job category	School managers	148.59±31.58	0.0001**
	Assistant	148.97±31.59	
	Teachers	130.07±31.50	
Participants level of education	Bachelor	139.58±31.42	0.030**
	Masters	152.65±30.77	
	Ph.D.	133.14±45.72	

* Derived by independent of t-test;
** Derived by ANOVA test

In addition, a significant correlation was observed between the resilience score and the age of the participant (*P* = 0.038 and r = 0.137); this was a positive but weak relationship. Also, there was a statistically significant correlation between school resilience and the year the school was built and reconstructed (P = 0.0001 and r = 0.294). Newly built schools and those that were recently renovated also had higher resilience. Meanwhile, there was no statistically significant difference between other variables such as school gender, school level (primary/first period and second period of high school), and the number of classes P> 0.05. Natural disasters are a major threat to the community. Students are among the most important disaster risk groups, and almost half of the country′s population is children and adolescents. Consequently, proper planning should be considered for upgrading the non-structural preparedness level and managing them in a disaster [8]. Therefore, this study aimed to determine the resilience of schools in Kermanshah during disasters. This study investigated the resilience of schools against disasters. The school′s resilience was at moderate levels because the mean (standard deviation) school′s resilience score was found to be 143 (32) in a range of 48–240, based on the quartile of resilience scores including first quarter 121, the second quarter 144 and third quarter 165. The resilience score is placed in the second quarter with moderate resilience and is consistent with Mirzaei et al. (2020) in Yazd. They reported the mean score of school resilience as 153. 30 (29. 57). School resilience is directly related to functional, educational, safety, structural, non-structural, architectural, communication, access routes, location, and equipment, which affect the overall resilience of schools; therefore, making changes in any of the components affects resilience [4]. Our finding indicated the highest score was recorded in the functional dimension, and the lowest score was obtained in the safety dimension, which is also in line with Mirzaei et al. (2020) [4]. Moreover, Grimaz et al. (2016) found the functional dimension critical in school safety, structural, non-structural, and school location dimensions [13].On the other hand, the safety of educational places has become a worldwide concern [14]. Therefore, the low score of schools in the safety dimension needs to be improved. Policy and decision-makers should consider reconstruction programs and deal with the consequences of disasters, especially since Kermanshah is one of the cities at risk of earthquakes and schools have experienced disasters.

It should be noted that investigating in risk recognition and risk reduction systems before disasters is more profitable than allocating costs after disasters [5]. Adopting structure standards and supplying infrastructures makes it feasible to increase schools′ safety and structural resistance. As a result, schools can provide a safe environment as well as a shelter for disaster survivors [14]. A lack of understanding and awareness about safety concepts, an unsafe environment, and the failure to use safety equipment results in considerable damages and losses [15]. In the present study, the average score obtained in the education dimension is moderate, which increases the need to pay attention to this issue. Other studies have also highlighted the need to equip schools with safety equipment, including fire alarm systems and extinguishers [16,17]. In examining the relationship between total resilience and its dimensions, the highest relationship was observed between functional and education and the lowest relationship between location dimensions. Education and function include infrastructure affecting disasters, communications, management, health, and education [18]. On the other hand, integrating resilience and crisis components into the school curriculum are other important components that influence Tong′s study [19]. The location of schools is one of the most effective areas of school resilience, which is considered acceptable according to the score obtained in this study and is in line with the study of Mirzaei (2019) [5]. Access to the main street, relief services, and avoiding high-risk locations prone to debris falling are to be considered [13]. Comparing the resilience of schools concerning the participants′ jobs, we found that the resilience of the schools where their principals participated in the study was higher than other job categories, which may be due to the type of work plan or the job category. Managers and assistants primarily oversee managerial, planning, and executive affairs. The study of Shah Ashfaq (2020) showed that emergency response, crisis management, and staff recovery increase school resilience [20]. Also, according to the findings of the study, the resilience of schools with participants with a master′s degree was higher than the group with a bachelor′s degree, which is consistent with Parishan (2020. This confirms that the safety dimension and educational degree have a significant correlation. [21]. Al-Shahri (2015) also emphasized that risk preparedness training, skills, experience, level of education, and demographic characteristics are key factors in managing crises [22]. This study also found a significant direct relationship between the age of participants and school resilience, which suggests that schools with older staff are more likely to be resilient to disaster. Perhaps it can be attributed to work experience and disaster management, which are considered capital instruments [23]. The findings of the study showed that nonprofit schools are more resilient than governmental schools, maybe because they are newer and follow the standard regulations. This finding is in line with the study of Yazdi (2009) [24]. The results showed that schools and participants with disaster experience were more resilient than others. These findings are consistent with the study of Wiwik (2021) [25]. Additionally, Onuma (2017) confirmed that previous experience with disasters increases preparedness [26]. However, it is contrary to Mirzaei et al. (2020) study [4] and Öcal and Topkaya (2011) [27]. In terms of construction and reconstruction years of schools, a correlation was observed with resilience, which is consistent with other studies. Shah (2018) recommended measures such as constructing and reconstructing vulnerable buildings and creating a place for emergency accommodation in crisis [28]. After identifying the most important risks, school renovation and reconstruction projects, modifying the destructive effects of disasters on them were proposed [29].

Furthermore, no correlation was found between the students, classes, area, floor numbers, and the number of school staff with resilience. It may be due to the random selection of schools from different regions. Moreover, the results indicated that the resilience of schools with rocky soil was greater than that of soft soil schools, which is in line with the results of the study by Jafari (2017). They investigated the effect of material on earthquake movements by considering different types of soil in the 2800 standard. It was found that the amplification of earthquake movements in stone construction was less than in other structures [30]. Also, the resilience of schools with concrete skeletal structures is greater than schools with masonry structures. Tafi et al. (2017) showed that despite minor concerns about concrete and steel buildings, the collapse of traditional buildings and materials is worrying. Due to the return period of earthquakes, there is a short opportunity for resilience [31]. Also, another study by Zahraei (2005) revealed that most masonry buildings are likely to suffer serious structural damage against moderate and severe earthquakes. Therefore, immediate action should be taken to strengthen them [32].

4. Conclusion

The X ±SD total score of school resilience in disasters was 143.61±32.5. Participants had the highest and lowest mean score in dimensions of function and safety, respectively. The results showed that the disasters resilience level in schools is directly affected by components such as school location, type of school structure, necessary equipment, appropriate architecture, non-structural factors, school safety, school access and traffic routes, relevant and practical education, and safe operation in this field. Also, by considering the costs and the potential, some areas such as equipment, safety, training, and performance can be improved with proper management and planning, thus increasing school resilience. The demographic characteristics of the participants, educational level, job category, and age of the participant in the research also had a positive effect. On the other hand, the structural characteristics of schools also affected resilience. In addition, identifying school characteristics, such as construction year, renovation, and the type of use, had a significant relationship with resilience. Moreover, an awareness of the general state of resilience can help policymakers and experts in areas such as health, safety, the environment, and crisis management develop an effective and efficient operational strategy to promote school resilience. Finally, considering all components of resilience and environmental factors, schools are still vulnerable to potential disasters and need to review and modify plans to develop preventive practices successfully.

4.1. Suggestions:

1.Establishing a disaster management system by establishing a safety and health committee by HSE regulations.
2.Conducting further studies and investigations on the resilience of schools against scarce and relatively new disasters in the country and studying earthquake-prone areas.

4.2. Research limitations:

In some schools, one limitation was the lack of up-to-date staff information about safety and health for school resilience. Second, lack or incompleteness of the identity and structural information of some schools. Third, some schools did not have the necessary cooperation, and in some schools, the principal was absent due to the coronavirus outbreak; thus, other schools replaced them. Fourth, it should also be noted that given the cross-sectional nature of our study, the association of school resilience with some characteristics cannot be interpreted as a causal relationship.

Authors' Contributions

Hamed Rahimi: Methodology; software; Collecting data; Writing-original draft; Writing-review; Editing. Hamed Mohammadi: Writing paper; Project administration; Writing-review; Editing. Khadijeh Hajimiri: Data analyzing; Methodology; Writing-review ; Editing.

Conflicts of Interest

There are no conflicts of interest.

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