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School Resilience Components in Disasters and Emergencies: A Systematic Review

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Abstract

Introduction: Schools have many roles and capacities before and after disasters. Resilience plays an important role in maintaining schools' performance after disasters. This study systematically reviewed the literature to identify the components of school resilience in emergencies and disasters.

Methods: In this study, Scopus, Web of Science, PubMed, and Google Scholar databases were systematically searched using "resilience", "risk", "disaster", "emergency" and "school" as keywords. In total, 8,053 studies were reviewed in several stages and eventually, 26 articles were selected. Other articles were excluded due to the lack of inclusion criteria or being irrelevant. Five other articles were included in the study by reviewing the references. Finally, 31 relevant articles were analyzed. The quality of the articles was assessed based on the PRISMA checklist.

Results: The evaluation of articles based on content analysis resulted in the emergence of 4 themes, 11 subthemes, and 99 codes. The themes included structural factors, non-structural factors, functional-process factors, and facilities. The subthemes included building standards, school environment, physical safety of the building, equipment and facilities, safety and retrofit of non-structural components, infrastructures, communication (internal and external), education, management, health, and human-financial resources.

Conclusions: The factors and dimensions affecting the resilience of schools were recognized. Different dimensions should be considered to increase the school's ability, and maintain its performance and appropriate response to disasters. The determined indices can be used by policy- and decision-makers when confronting emergencies and disasters to assess the resilience of schools against the risks.

Keywords: Resilience, Disasters, Schools, Systematic Review

1. Introduction

Nowadays, natural and man-made disasters threaten the lives of millions of children in many parts of the world. As a vulnerable group, children are directly affected by disasters. Due to the increasing frequency and severity of risks, children are more vulnerable than before (1, 2). According to the United Nations Children's Fund (UNICEF) (2013), the number of children aged < 18 years who are affected by disasters would increase to 2.5 billion by 2050 (3). As students, most children spend much time with their teachers. They spend more than seven hours a day and 260 days a year in schools (4). Since teachers and students may lose their lives in emergencies and disasters, these phenomena may have serious impacts on educational services and suddenly interrupt the educational process leading to mental disorders in students (5, 6).

In spite of significant efforts on the safety and readiness of schools in disasters, the negative effects of disasters are still evident in schools. These disasters may, for instance, lead to the collapse of schools' buildings and contribute to physical harm of children. For example, the 2006 storm in Da Nang, Vietnam, resulted in the complete or partial destruction of 5,120 schools, with a total esti-

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mated loss of $300 million (7). Recently, the Ministry of Education, Culture, Sports, Science, and Technology of Japan reported that some 6,284 public schools were demolished and 733 students and teachers lost their lives as a result of the Tokyo earthquake and tsunami in 2011 (8, 9). In Iran, more than 90% of local education institutions, in which 10,000 students were studying, were destroyed in the 2003 Bam earthquake (10). Also, information available about national schools of Iran (11) shows that 22% of the total population of Iran (nearly 14 million students) are at risk of moderate to severe earthquakes. The latest survey by the Iranian School Rehabilitation Center shows that about 65% of all schools have no organizational capacity to withstand a possible earthquake (12).

Given the importance of school resilience, high-level documents including the Hyogo Framework for Action 2005 - 2015 (13-15)) and the Sendai Framework for Disaster Risk Reduction 2015 - 2030 (15-17) recognize the school location safety, constant access of children to education, and the use of education for assisting countries as priorities for reducing the risk of disasters (18-20).

Resilience is a multifactor term with many definitions in various fields such as health and psychology (21, 22). Resilience has been defined as "the ability of a social or environmental system to absorb disorders by maintaining a basic structure, ways of functioning, organizational capacity, and the ability to adapt to stress and change." (9, 23).

Disaster risk reduction training is essential for having a sustainable community (2, 9). The importance of disaster risk reduction training in schools is due to its role in creating safer schools, increasing the resilience capacity, and reducing the damage caused by natural disasters. Its mere integration in the curriculum alone not enough but relevant issues such as structural and non-structural safety, statute law, management mechanism, qualified human resources, adequate budget, strong cooperation, appropriate warning system, and risk assessment should also be considered (24-26).

The United Nations and the Coalition for Global School Safety, as well as some researchers such as Izadkhan (27), Dixit (28), and Wisner et al. (29), identified the building safety and disaster education as important factors in school safety. According to Shiwaku et al. (30), it is important to focus on the concept of education for teachers and principals and the relationship between teachers and urban disaster management planners.

Given the important role of schools after disasters (5, 31, 32) and the distribution of schools throughout a city, they can be considered as shelters for homeless people and a place for medical clinics and other emergency operations. After a disaster, the schools' activity will create a sense of normal condition in the community and help people return to normal status after an event (33).

Studies on school resilience have focused more on the role of schools before and after disasters and the existence or absence of disaster readiness plans. While school resilience embraces a variety of dimensions and components, each study has focused on a single dimension.

2. Objectives

It is necessary to conduct a study to review and summarize previous studies. As resilience is multidimensional and no comprehensive approach was followed in a systematic study to identify the factors affecting the disaster risk reduction (DDR) and schools' resilience and preparedness at the time of events and disasters, this systematic study was conducted to identify these factors.

3. Methods

The present study was a systematic review of the articles available on Scopus, Web of Science, PubMed, and Google Scholar databases. The study was registered in PROSPERO with code CRD42018106114. The study was designed based on the following research question: What are the dimensions and components affecting schools resilience at the time of disasters? To answer the question, we selected the keywords including ("resilien* OR risk"), ("disaster OR emergen*)" and "school" according to MeSH terms. The PRISMA checklist (34, 35) was used for assessing the validity of the articles. This checklist evaluated the three major parts of the paper, including presentation, introduction, and methodology. In the next step, the articles were evaluated by the STROBE checklist (36, 37), with 22 items to assess the title, abstract, introduction, methods, results, and discussion sections of articles.

3.1. Data Sources

The search was carried out without any limitation in Scopus, Web of Science, PubMed, and Google Scholar databases from May 10, 2018, to August 30, 2018.

3.2. Search Strategy

Based on the research question, keywords were selected according to MeSH terms. The opinions of professors, experts, and the keywords of the related articles were also used. The search strategy was defined based on each database. The search combination for PubMed was as follows:

"(Disaster* OR emergen*) AND (resilien* OR risk) AND (school)"

Search Strategy in PubMed was as follows:

(Disaster* [tiab] OR emergen* [tiab] OR disaster [MeSH]) AND (school [tiab] OR kindergarten [tiab] OR school [MeSH]) AND (resilien* [tiab] OR risk [tiab] OR risk [MeSH])

3.3. Inclusion Criteria

All articles including original articles, short communications, letters to editor, editorials, RCTs, systematic reviews, and articles presented at conferences and international congresses on the main topic of the study, i.e. dimensions and components affecting school resilience at the time of disasters, as well as articles related to the identification of the components of school resilience, schools and disasters, schools' safety and retrofitting against hazards, disaster plans, and school readiness were included in the study. It should be noted that only the articles that were in English and had been published until August 30, 2018, were included in the study.

3.4. Exclusion Criteria

Studies not addressing the components of school resilience, examining community and individual resilience, examining the psychological effects of disasters on students, and post-traumatic stress disorder (PTSD) PTSD were excluded.

3.5. Information Extraction

The articles were selected and evaluated based on the PRISMA guidelines. The PRISMA guideline (34, 35) is a 27-item checklist that examines the title, summary, methods, results, discussion, and source of funding of the studies. All search results were inserted into EndNote X8. First, the duplicate articles were removed. Then, unrelated studies were removed by examining the title and then reviewing the abstracts. Irrelevant studies were further excluded in the next stage by reviewing the full texts by two independent researchers according to inclusion and exclusion criteria. Finally, the full texts of the remaining articles were examined based on the PRISMA standard checklist. In the next step, these articles were evaluated by the STROBE checklist (36, 37), with 22 items related to the title, abstract, introduction, methods, results, and discussion sections of articles. Finally, two researchers (the student and the first advisor professor) independently reviewed the quality of the articles and in the case of disagreement, the article was reviewed by the third researcher (the second advisor professor).

4. Results

Overall, 8,053 articles were extracted from the mentioned databases. Next, 1,690 articles were deleted as they were duplicates. Thus, 6,370 titles and abstracts were reviewed, which resulted in 224 full-text articles to review. Finally, 26 articles were selected and the other articles were removed due to the lack of necessary criteria or being irrelevant. Five other articles were included in the study by reviewing the references. Therefore, in total, 31 relevant articles were analyzed. The extracted information in the first level included the authors' name, country, year, type of disaster, study objective, methodology, and the factors affecting school resilience. The results are shown in Figure 1.

4.1. Descriptive Analysis

The examination of the studies showed that out of 31 studies related to the research question, 21 (67%) were conducted in Asian countries. Also, 54% of the selected studies were original articles. The methodology of 12 studies was descriptive and 14 studies were conducted cross-sectionally. All of the finally selected papers addressed the components affecting resilience against disasters; 83% addressed natural disasters, 9.6% addressed man-made disasters, and 7.4% addressed both hazards. Moreover, 45%, 38%, and 17% of the studies directly, indirectly, and both directly and indirectly pointed to the components of school resilience, respectively. A description of the articles is presented in Table 1.

4.2. Qualitative Analysis

The evaluation of articles based on content analysis resulted in the emergence of four themes, 11 subthemes, and 99 codes. The themes included structural factors, non-structural factors, functional-process factors, and facilities. The subthemes included building standards, school environment, and physical safety of the building in the structural factors theme, equipment/facilities, and safety and retrofit of non-structural components in the non-structural factors theme, infrastructures, communication (internal and external), education, management, and health facilities in the functional-process factors theme, and human-financial resources in the facilities theme (Table 2).

5. Discussion

This study identified the related indices of school resilience that may increase the ability to respond to disasters. The review of 31 finally selected papers showed that many components are directly and indirectly involved in

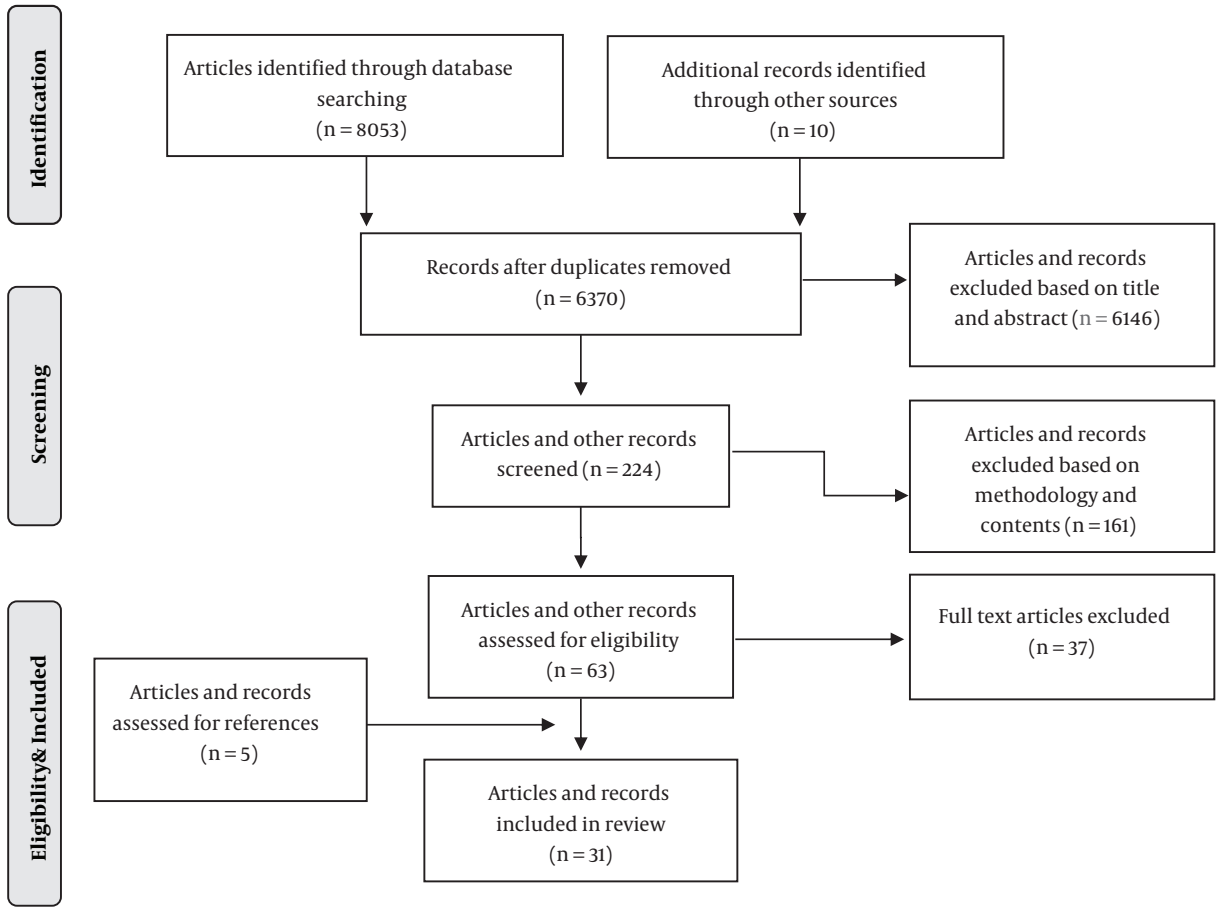

Figure 1. Search and article selection diagram

school resilience. Considering the number of factors affecting the concept of school resilience, these studies addressed the disaster response programs in schools (2, 5, 33, 42, 44, 45, 56), the assessment of school readiness in emergencies and disasters (20, 30, 43, 48, 51, 53, 58, 59), the role of schools in disasters (38, 57, 60), the safety of schools (39-41, 46, 54) and school resilience (4, 24, 47, 49, 50, 52, 55, 61).

It seems that each study examined the resilience of schools based on the authors' expertise not based on a comprehensive approach from the perspective of experts in disaster. School resilience is wider than school readiness, safety, or disaster response programs. It needs to be considered to increase a school's ability to maintain its performance and appropriate response to disasters. The present systematic review study divided the four dimensions of school resilience according to a systematic approach to structural, non-functional, functional-process and facilities factors (Figure 2). However, the studies by Santa-Cruz et al. (50), Dixit et al. (33), Vahdat and Smith (12), and Kisioglu et al. (39) addressed structural components and studies by Naseri and Kang (56), Oktari et al. (61), Kokcu et al. (48), Graham et al. (42), and Lee et al. (44) addressed the functional components separately. The studies by Tong et al. (24) and Shiwaku et al. (52) merely focused on physical and functional components while the study by Grimaz (51) focused on school location, and structural, non-structural, and functional dimensions. According to these studies, all these components are characterized by multi-risk assessment, training analysis, planning, and student-oriented investigation. However, the present study considered all structural, non-structural, and functional dimensions in various areas of management, education, health facilities, communication, and infrastructure. The financial and budget dimensions are comprehensive in this study.

Construction standards, school environment, and physical safety of buildings were among the structural dimension indices that included structural features, build-

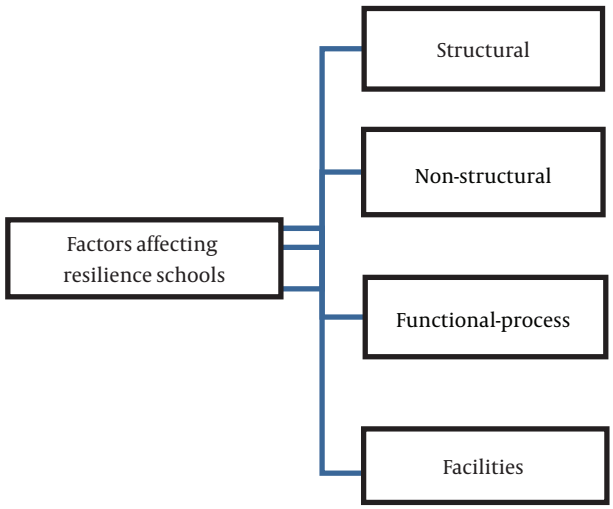

Figure 2. School resilience indices based on the analysis of selected articles

ing architecture and safety, retrofitting, and renovation in school resilience. Also, the features of the location of schools such as the topography of the area, type of soil, foundation of the earth, and placement in flat or elevated zones were also considered as important elements of the structure (4). Given the importance of structure in school resilience, structural interventions are necessary to protect the lives of students and school buildings. As the Dixit et al. study showed, it is important to reduce the vulnerability of school buildings but it is not considered (62). Shah et al. (58) recommended measures such as the reconstruction of vulnerable buildings, constructing a place for emergency evacuation, and storage of essential goods to enhance facilities. Since many deaths are caused by the demolition of buildings, the number of deaths from disasters can be reduced if the buildings are designed appropriately and checked regularly. Students are at high risks in schools due to their high population density. As a result, the physical safety of schools should be considered more closely (Table 2). Kisioglu et al. argued that for a school building to be considered safe, the maximum number of students in a classroom should be 40 students and the required space for each student should be 6 m^2 (39).

Important factors before building a school are the assessment of site stability, assessment of the building retrofitting opportunities, or the change of location to a stable and secure place. In the study carried out by Vahdat and Smith (12), the type of structure, engineering method, age of the building, population density, age group of users, and the conditions of the school location, such as soil type and instability of the area, were considered as the risk factors of school structure vulnerability. In areas surrounded by mountains or sea, the level and severity of disaster effects are high. The Department of Education and schools' managers should prioritize risk prevention and risk reduction everywhere, especially in places that are most at risk.

School location is another index of resilience. Schools in the main street, plains, and flat areas, and schools having fewer floors to facilitate access to the distribution of humanitarian assistance and, if necessary, evacuation of injured victims are regarded as positive featured schools for post-disaster measures. Relief measures are difficult in crowded areas with heavy traffic, unstable and sloping land, and areas without roads and highways due to difficult road access (50). Designing emergency exit routes and places for evacuation and shelter is another important index of resilience in construction standards. Also, examining building vulnerability, retrofitting, and proper rehabilitation of schools is necessary to ensure safe learning facilities for students and temporary shelters for the community after disasters (60). The roofs of schools can be used as a place of evacuation during a hazardous event such as flood. In some areas, e.g., the city of Banda, Indonesia, where school roofs are not flat, the schools cannot use the roof as a place for emergency evacuation (54). Emergency exits are important routes for evacuation during disasters. It is important to install signage along the emergency exit to show the path because of the congestion and risk of harm to employees and students when leaving the school building after disasters (50). Moreover, it is also important to pay attention to the safety of exit routes, the height of the rails, and the traffic control of population to prevent damage (50). Resilient schools can be safe environments for emergency resettlement in the event of disasters, as in the Philippines where school buildings are considered as a place for emergency post-disaster relief (63).

Structural safety was another example of resilience in this study. Safety tips for the building dimensions include 120 cm above the floor for the height of windows, the width of 90 cm for the doors, the width of 130 - 140 cm for the steps, and 15 cm for the height of the stairs. One of the standards of classroom doors is an outward swing to avoid the students' injury when they rush towards exit doors at the time of disasters (39). For a school to be structurally resilient, it should have just a few floors so that in the event of outbreak of fire, in particular, the risk of injury and suffocation due to congestion in stairs and exit routes is minimized (40). Other design factors that affect school building resilience are the shape and size of windows and classrooms. In this regard, Hassanain argues that the smaller size of the windows and classrooms is a factor in reducing the expansion of the fire due to the limited oxygen available at the time of fire. The flaring out of fire is a func-

tion of the scale of the building; large buildings contain more flammable materials than smaller ones (40). On the other hand, in Kisioglu et al.'s study the number and shape of windows were reported to be important for providing adequate light (39). Therefore, although large windows are desirable from an architectural perspective because of their lighting, small windows are recommended from the viewpoint of safety. It is recommended to investigate both views in a balanced way to increase resilience.

Another important factor in school resilience is the non-structural component. In this study, the equipment and facilities of school buildings, as well as attention to safety and retrofitting of non-structural components were recognized as important in this dimension. The layouts of non-structural elements (e.g. false ceilings, bookshelves, chimneys, ceiling fans, and libraries) are important as they can cause injury or death by collapse (49). Removing barriers to school evacuation, installing high rails along the stairs, and non-slippery rails are the safety points of non-structural components (39, 50). In this study, electrical systems including emergency power supply, electrical wiring systems, electrical covers, electricity generators, and heating systems were among the most important equipment for school resilience. Kisioglu et al. (39) noted that, in Turkey, most classrooms had central heating systems and only one school used coal heaters. Modern central heating systems are considered to be a safety improvement contributing to school resilience (64). This is important in many cases because of the risks of heaters, including carbon monoxide poisoning, burning traumas, and uncontrollability of heaters.

Based on the results of this study, the essential fire-fighting equipment in schools includes fire extinguisher capsules and hoses, fire-proof doors, gas shut-off valves, fire alarm system, alarm system, periodic check-ups, and recharge of fire extinguisher capsules. In the study by Hosseini and Izadkhah, it was suggested that a fire-fighting team be formed to train and equip schools with fire extinguisher capsules before an earthquake. In addition to the provision of fire extinguishers, it is suggested the students be trained on how to be calm in fire situations; we should prepare and guide them on fire safety and, when it is not possible to extinguish the fire, teach them how to evacuate the school (41). Hassanain (40) argues that building facilities including fire detection and fire alarm systems, smoke detectors, fire control and fire inhibitors, fire extinguishers, fire sprinklers, and evacuation equipment such as exit doors, emergency lighting, and signage are also important.

Another index that affects school resilience is the functional-process dimension that includes infrastructures affecting disasters, communications, management, health, and education. Providing basic services such as water supply, electricity, telephone communication, and annual communication programs with the police, fire department, "civil defense, school committee, parents, and family was recognized to be important in this dimension. This study showed that school readiness and resilience would be increased by educating children and training school staff including office staff, teachers, and managers. Schools can also play an important role in educating the community and establishing cooperation among different groups of society not only in emergencies, but also before and after disasters. The educational content for this dimension was considered to be emergency situation recognition, school evacuation, disaster preparedness, hazard identification, risk reduction measures, earthquake preparation, school response program, drilling and planning for preparation, evacuation, emergency response, first aids, and school activity persistence after disasters. Disaster preparedness is associated with specific social and economic characteristics including education, household income, sex, household resources, proximity to hazardous seismic areas, preparedness behavior and risk experience (65). Researchers believe that there is a special relationship between resilience and culture, the population at risk, advertisement and protection factors (66). Also, changes in social, economic, and environmental conditions can affect school performance (9).

It should be noted that the level of awareness and commitment of local communities is increased through the education provided by teachers, health workers, parents, religious leaders, community-centered organizations, and community interventions. These teachings have a positive psychological impact on crisis management by local authorities and humanitarian agencies (50). In Shiwaku et al.'s study the important factors in school resilience were disaster educational programs for teachers, staff, students, parents, and people exposed to disasters, participation in disaster preparedness programs, sharing disaster preparedness programs for teachers, staff and parents, school-family emergency information sharing, and parents' involvement in school activities (52). On the other hand, the integration of disaster components into the curriculum, school regulations, course syllabus, preparation for a disaster management plan, emergency management and preparedness plan, rehabilitation management program (school reopening program), and disaster-related education (parents, teachers and students' participation in drill) are other important components affecting resilience in the study by Tong (24). The results of this study also confirmed the direct or indirect impact of these indices on school resilience level.

As necessary facilities effective in school resilience are

human and financial resources. The role of staff and students is important in human resources (44). Schools that have different stakeholders including internal (students, parents, families) and external (emergency services, CDEM organizations, community) ones are interested in emergency preparedness efforts (5). It should be noted that investing in risk reduction before disasters is more beneficial than allocating costs after disasters. Expenditures mentioned in the studies to reduce the disaster risk include the cost of replacement from the local government fund, the cost of parental cooperation, the cost of the local community, and the cost of other organizations. The budget dedicated for preparedness and response programs, a separate budget for reconstruction after disasters, the budget for supervision and monitoring, funding for the support of students with special needs, and funding for training activities are also mentioned in the studies (24, 52).

In this study, the indices affecting school resilience in different areas were identified and discussed. Identifying these components, in addition to preserving the lives of students and the school staff in disasters, can help increase the readiness of schools in providing an appropriate post-disaster response.

5.1. Conclusions

This study identified the effective indices of school resilience. Based on the review of 31 related articles, the four structural, non-structural, functional-process, and facility areas were found to be important for school resilience at the time of disasters. According to the findings of the study, the functional and process components are important factors that can increase the readiness of schools through appropriate education, communication, planning, and management. In the structural changes, as retrofitting requires high costs, one can take appropriate functional measures using available resources, and properly managing human and financial resources to increase school resilience. Encouraging schools to establish appropriate internal and external communication increases the preparedness of schools to deal with emergencies and disasters. Increasing the risk perception is effective in educating students for improving students' real performance in disaster risk reduction, and since student education can lead to the transfer of knowledge to families and the community, it is an important component that can be used to invest in it. It should be noted that the management and prioritization of effective factors in reducing the risk of disasters in schools are crucial for the improvement of spatial variability. The identified indices can be useful to policy- and decision-makers in the area of disasters and accidents for assessing school resilience at the time of disasters.

5.2. Research Limitations

Although a comprehensive systematic outlook and a disaster risk management approach to school resilience dimensions are the strengths of this study, the lack of access to the full text of some studies was a limitation, which was attempted to be resolved through correspondence with the authors and establishing inter-university links. In addition, the study of English-language articles and the non-retrieval of the texts in other languages were other limitations of the study.

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Footnotes

Authors' Contribution: Samaneh Mirzaei and Leila Mohammadinia independently reviewed the quality of the articles and in the case of a disagreement, the article was reviewed by Khadijeh Nasiriani and Abbas Ali Dehghani Tafti. Samaneh Mirzaei, Leila Mohammadinia, Khadijeh Nasiriani, and Abbas Ali Dehghani Tafti participated in the conceptualization and design of the study, data analysis, and manuscript preparation. Zohreh Rahaei, Hamid Reza Amiri, and Hossein Falahzade participated in manuscript editing and manuscript review.

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Table 1. Details of Articles on Effective Components of Schools' Resilience Included in This Study

First Author	Country	Year	Type	Disaster		Study Objective	Methodology	Way of Referring to the Factors Affecting School Resilience
				Man-Made	Natural			
1- Shaw (38)	Japan	2001	Literature review		*	Studying the role of schools as a safe environment after disasters	Descriptive	Indirect
2- Kisioglu (39)	Turkey	2005	Original research	*	*	Studying the physical environment inside the school with regard to the safety and security of schools	Cross-sectional	Direct/Indirect
3- Hassanain (40)	Saudi Arabia	2006	Literature review	*		Investigating fire safety in the design phase and in the facilities of schools	Descriptive	Direct/Indirect
4- Hosseini (41)	Iran	2006	Literature review		*	Development of an appropriate earthquake management system for Iranian schools, the comprehensiveness of the proposed "Emergency Management System" for schools and its approaches to building a "safety culture" in society	Descriptive	Indirect
5- Graham (42)	United States	2006	Original research	*		Providing public documents in the United States for preventing and responding to an incident with mass casualties in schools	Cross-sectional	Indirect
6- Shiwaku (43)	Nepal	2007	Original research		*	Future outlook of school disaster education in Nepal	Cross-sectional	Indirect
7- Lee (44)	United States	2008	Original research		*	Effectiveness of school crisis management programs in relation to Hurricane Katrina	Cross-sectional	Direct/Indirect
8- McEntire (45)	United States	2008	Literature review		*	Implementing the vulnerability management policy and highlighting the strengths and weaknesses of school resilience	Descriptive	Indirect
9- Ochola (4)	Kenya	2010	Original research		*	Studying schools' resilience against flood and risk reduction strategies and setting standards for school infrastructure	Cross-sectional	Direct/Indirect
10- Öcal (5)	Turkey	2011	Original research		*	Developing disaster and school readiness programs by increasing the awareness of school managers to reduce the effects of earthquakes on buildings and individuals inside	Cross-sectional	Direct/Indirect
11- Tong (24)	Vietnam	2012	Literature review		*	Developing a method for measuring educational resilience to deal with natural disasters	Descriptive/psychometrics	Direct
12- Darshan Shrestha (46)	Indonesia	2012	Case study		*	Vulnerability assessment and retrofitting of school buildings	Descriptive	Indirect
13- Thi My Thi (47)	Vietnam	2012	Original research		*	Disaster risk reduction education in schools	Cross-sectional	Direct

14- Kokcu (48)	Turkey	2012	Literature review	*	*	Assessment of school readiness in the case of disasters and emergency situations	Descriptive	Direct
15- Dixit (33)	Nepal	2014	Original research		*	Nepalese earthquake safety program as an effective tool to reduce the risk of earthquake damage in public schools of Nepal	Cross-sectional	Direct
16- Vahdat (12)	Iran	2014	Case study		*	Evaluating the resilience capacity of school buildings that are exposed to different levels of seismic hazard	Cross-sectional	Direct
17- Grimaz (49)	Italy	2016	Literature review		*	Reviewing of all potential features in constructing a school	Descriptive	Direct
18- Santa-Cruz (50)	Peru	2016	Case study		*	Dimensions of community sustainability in reducing seismic risk in schools	Descriptive	Direct
19- Ersoy (51)	Turkey	2016	Literature review		*	Investigating school buildings and earthquake preparedness	Descriptive	Indirect
20- Shiwaku (52)	Japan	2016	Original research		*	Assessing the resilience, strengths, and weaknesses of schools	Cross-sectional	Direct
21- Lai (53)	United States	2016	Literature review		*	Investigating schools and disasters	Descriptive	Direct
22- Sakurai (54)	Indonesia	2017	Original research		*	Safety assessment in primary schools in terms of safety, crisis management, and disaster education	Cross-sectional	Direct
23- Dwiningrum (55)	Indonesia	2017	Original research		*	Creating a valid and suitable tool to measure the resilience of schools and understand the teachings of students to create a resilient school	Qualitative and quantitative methods	Direct
24- Naseri (56)	Afghanistan	2017	Original research		*	Specific needs for creating an educational planning system to prevent accidents	Cross-sectional	Indirect
25- Tipler (20)	New Zealand	2017	Original research	*	*	Investigating the level of emergency preparedness activities in schools	Descriptive	Direct
26- Sheffield (2)	United States	2017	Literature review		*	Investigating climate change and schools	Systematic review	Indirect
27- Mutch (57)	New Zealand	2018	Original research		*	The role of schools in supporting the community after disasters	Qualitative research	Indirect
28- Shah (58)	Pakistan	2018	Original research		*	Evaluating the emergency preparedness of schools to inform policy decisions to improve school safety	Cross-sectional	Direct
29- Sakurai (59)	Indonesia	2018	Original research		*	Assessing school safety and readiness against disasters	Cross-sectional	Direct
30- Ilumin (60)	Thailand	2018	Conference paper		*	Evaluating emergency performance index to save the personnel and students' lives and educational performance index for continuing post-disaster training in school buildings	Case-study	Indirect
31- Oktari (61)	Indonesia	2018	Original research		*	Enhancing the resilience of society through joint school and community programs	Case-study	Indirect

Table 2. Effective Factors on School Resilience in Disasters and Emergencies Based on Content Analysis of the Final Articles Reviewed Systematically in 2018

Theme/Subtheme	Code	First Author/References
Structural factors		
Building standards	Building's interior architecture, time of reconstruction, emergency exit path, appropriate location, construction based on the severity and type of regional hazards, the shape, size, and height of the building, building age, structural type, retrofitting, roof shape, refuge area	Hassanain (40), Dixit (33)), Shiwaku (52), Grimaz (49), Sakurai (54, 59), Ochola (4), Vahdat (12), Santa-Cruz (50) McEntire (45), Kisioglu (39), Mutch (57), Shah (58), Darshan Shrestha (46)
School environment	Safety of the school location, access of emergency services to the school (absence of heavy traffic), geographic region, School environment, the physical location of the school	Santa-Cruz (50), Shiwaku (52), Grimaz, (49), Sakurai (54, 59), Kisioglu (39), Shah (58), Sheffield (2)
Physical safety of the building	Safe flooring, the width and height of stairs, classroom lighting, corridors parallel to the classroom, Swing direction of the door (outward), number of toilets, number of floors, window height, number, and size, classroom size, classroom door size, window guardrails, student's space	Kisioglu (39), Hassanain (40), Mutch (57), Ilumin (60), Darshan Shrestha (46)
Non-structural factors		
Equipment/facilities	Portable toilets, showers, clothes washing and drying facilities, food, water supply, and other essential equipment, fire-fighting equipment (fire extinguisher capsules and hoses, fire-proof doors, gas shut-off valves, fire alarm system, alarm system, periodic check-up, and recharge of fire extinguisher capsules), electrical systems (emergency power supply, electrical wiring systems, electrical covers, and electrical generators), lightning rod, heating system, satellite and wireless phone, air conditioning systems, emergency facilities (first aid box)	Kisioglu (39), Hassanain (40), Mutch (57)
Safety and retrofit of non-structural components	Obstacles (rods, walls, and wire fences) around the school garden, unoccupied exit paths and stairs, controlling the handling of hazardous materials, Stair railings with suitable height, Safety of false ceilings, bookcases, chimneys, libraries, ceiling fans, and decorations, proper storing and handling of flammable materials and hazardous chemicals, Tightening tall equipment to the wall, tightening shelves and laboratory equipment, emergency exit doors, door types (visible interior), the material of rails, thermal insulation of walls and ceilings	Tipler (20), Grimaz (49), Kisioglu (39), Oktari (61), Ersoy (51), Hassanain (40), Shiwaku (52), Kokcu (48), Mutch (57), Shah (58), Sakurai (59), Santa-Cruz (50), Öcal (5), Ilumin (60)
Functional-process factors		
Infrastructures	Providing disaster equipment, appropriate support systems for psychological counseling for students and staff, class, social, and economic characteristics, the readiness of the school community, Access to safe places for people with disabilities, maintenance of documents, coverage of basic services, the student population in the class, evacuation map	Kisioglu (39), Hassanain, (40), Öcal (5), Kokcu (48), Sakurai (54) Grimaz (49), Lee (44), Santa-Cruz (50), Dixit (33), Naseri (56), Oktari (61), Shah (58)
Communication (internal and external)	Communication with external stakeholders, parents' communication with schools, communicating with other schools and organizations, enhancement of cooperation and communication with the community, collaboration with social organizations, people-centered organizations, communication with the media, telecommunication, communication with staff, annual communication plan	Shiwaku (52), Thi (24), Santa-Cruz (50), Oktari (61), Lee (45), Tipler (20), Shah (58)

Education	Teachers, employees, and parents knowledge of and participation in disaster programs, Increased awareness of disasters among students and staff, individual and organizational preparedness training (students, teachers, and parents), promoting local communities' level of awareness and commitment, school disaster preparedness education experiences, Life skills and hazards training to the family, educational content, independent and continuous implementation of training courses, recording the training, promoting education awareness, school evacuation experience, drill	Dixit (33), Ersoy (51), Lee (44), Hassanain (40), Shaw (38), Tipler (20), Hosseini (41), Shiwaku (52), Kokcu (48), Naseri (56), Santa-Cruz (50), Sakurai (54, 59), Dwiningrum (55), Mutch (57), Shah (58), Lai (53), Shiwaku (43)
Management	Disaster preparedness plan design, determination of responsibilities in the plans, risk, vulnerability, and school capacity analysis based on past hazards, execution of expected structures at the time of upcoming events, developing regulation and policies, determining the command chain at the time of accidents, installing initial alert systems, collaborative programs with neighboring schools, coordination and support, planning and update of plans, work continuity plan after disaster	Hosseini (41), Lee (44), Oktari (61), Kokcu (48), Graham (42), Tipler (20), Santa-Cruz (50), Shah (58), Sakurai (54, 59)
Health facilities	Hand sanitizer products, water treatment and sanitation, school environment health team, waste recycling and collection system, food safety conditions	Shiwaku (52), Thi (24), Kisioglu (39), Grimaz (49), Ochola (4), Shah (58)
Facilities		
Human-financial resources	Human resources, budget and financial resources, insurance coverage	Shiwaku (52), Ochola (4), Tong (24), Oktari (61), McEntire (45), Lee (44), Naseri (56), Kokcu (48), Shah (58)