Research Paper: The Approach of a New Model of Earthquake Crisis Management in the Classification of Vital Arteries

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ABSTRACT

Background: Iran is one of the earthquake-prone countries in the world that have experienced earthquakes with a magnitude of more than seven on the Richter scale, which has caused significant financial, human, economic, and social losses in society. In earthquakes where the vital arterial system is severely damaged, the community's life is threatened and sometimes causes significant damage. The purpose of this study is to investigate the effect of the earthquake on vital arteries and to design a new approach to earthquake crisis management in the classification of vital arteries.

Materials and Methods: This study was descriptive applied. The study population consisted of technicians and experts in management and civil engineering in Isfahan Province, Iran. Considering that the study population is 265 people, all of them were studied with the assumption of a confidence interval of 0.95 and an error of 0.05. The study data were collected by a questionnaire. Because of the normality of the data, the data were analyzed with the Pearson correlation coefficient in SPSS software.

Results: The results of data analysis and Pearson correlation coefficient test show a significant relationship between the classification of vital arteries based on new structuring with crisis management and its key role in earthquake crisis control. The passive defense was the most important component and the most relevant among effective approaches to managing vital arteries crises.

Conclusion: By creating this proposed model of earthquake crisis management, a new classification was made for the system of vital arteries. Also, It provides a proper performance in different situations of before, during, and after social crises. It is also necessary to form a headquarter called the Social Crisis Management Headquarter based on efficient strategies and the necessary implementation and training.

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1. Introduction

Looking at the history of human life on Earth shows that humans have always been exposed to various natural hazards [1]. Developments in human life history and the frequency of accidents and disasters indicate the certainty of disasters. So far, disasters have caused great concern in human society [2]. Natural disasters refer to changes that occur in environmental conditions. They disrupt the natural life process of people and expose them to factors that are dangerous and destructive to the environment. They also have devastating effects on human settlements and inflict extensive economic, social, and environmental damage on communities. In other words, natural disasters have always existed as a recurring phenomenon throughout human life and will continue to exist in the future [3].

Asia ranks first in the world regarding the prevalence of natural disasters. Iran is the fourth country in Asia after India, Bangladesh, and China, and the sixth country in the world regarding the high number of disasters. Iran is one of the most disastrous countries in the world due to its geographical location, climatic conditions, and geological situation. Every year, floods, earthquakes, and other disasters cause much damage and losses to the country [4, 5].

Studies conducted in the world show that the vulnerability of different groups of people living in high-risk areas varies depending on their standard of living and social and economic status in different parts of the world [6]. Urban vulnerability to natural hazards, including earthquakes, is a function of human behavior and expresses the degree of readiness or unpreparedness of socio-economic and physical systems in urban areas that are affected by the effects of natural hazards [7]. Vital arteries are structures on which the continuity and life of society depend, and in a sense, they are the foundation of civilization. In an event such as an earthquake, these structures can be as crisis-relieving as they can be crisis-causing. Vital arteries comprised highways, tunnels, bridges, roads, and pipelines. In recent decades, the increasing development of these systems and the dependence of urban and even rural life on them, especially in industrialized countries, has rightly turned these systems into vital arteries [8].

In many earthquakes that have occurred around the world, the vital artery system has suffered severe damage that threatens the life of society and sometimes has caused significant damage, such as the San Fernando earthquake in 1971. More than 80% of the damage caused by the quake was related to fire due to the rupture of gas pipelines [9]. Other systems of vital arteries have a special significance that overshadows the life of society before and after the crisis. Some centers and places should be considered as vital arteries of society due to their sensitivity and importance, for example, educational centers of children and adolescents, as well as centers of security and educational measures [10].

Earthquakes are always a serious threat to economic and social development. After an earthquake, the result of human efforts and long-term investments is suddenly destroyed, and the valuable resources of development are affected in some ways by its adverse effects. As a result, the country's current plans must be stopped to allow the transfer of resources from long-term plans to immediate and short-term plans of rescue, relief, and reconstruction. Population growth, accelerated urbanization, depletion of natural resources, and disasters caused by new technologies in countries with the potential for natural disasters and earthquakes highlight the need to improve disaster prevention and preparedness techniques in all sectors [11].

Crisis management involves a series of continuous and dynamic operations and actions and is generally based on the class management function that includes planning, organizing, leading, and controlling. Crisis management is a set of measures taken before, during, and after an accident to reduce its effects and complications as much as possible [10].

Crisis management is a purposeful and planned effort to maintain the desired situation in crises and minimize the pressures and disturbances created, as well as provide a set of appropriate measures to deal with plans, programs, and disasters and assess the social vulnerability of human settlements to natural hazards [12]. Proper crisis management is the request and need of stakeholders and community members from officials and stakeholders. Crisis management will directly affect the future and stability of the economic and social system of society [13]. Because of the unpredictable and ambiguous nature of crises, their economic, social, environmental, and destructive infrastructural effects will be much more severe if they are not adequately managed [14].

Controlling the natural disaster crisis is so important that the UN General Assembly in December 1987 declared the 1990s International Decade for Natural Disaster Reduction [15]. Although today, with the advancement of technology and modern knowledge, human beings have made significant progress in various fields, at the same

time, their vulnerability to crises has increased in recent decades. Besides the natural threats, due to the political geography, our homeland has always been and will be exposed to unnatural threats, too. Therefore, passive defense and crisis management are the most important approaches and strategies in the field of passive defense [16-28].

The damage that the vital and infrastructural arteries suffer during the earthquake will cause some casualties. Also, those who survived the earthquake will have irreparable damage in case of service disruption. In this study, we try to scientifically study the relationship between the effect of the earthquake on the infrastructure and the role of this phenomenon on social crisis management while examining the impact of the earthquake on vital arteries. Also, in terms of the relationship between earthquakes and increasing social crises, a new classification is proposed for the system of life lines, which can reduce social crises.

2. Materials and Methods

This research was a descriptive applied study. The study population comprised technicians and experts in civil and social affairs in Isfahan Province, Iran. Sampling in this study was done by simple random method. The questionnaire was used as a data collection tool to identify and measure variables. In this study, a researcher-made questionnaire was used, including 23 questions. These questions assess 7 variables of intention, the role of vital arteries, coping measures, sense of usefulness, sensitivity to crisis management and passive defense, empowerment, and problem-solving. The Cronbach α method was used to estimate the validity of the questionnaire. The Cronbach α reliability coefficient was calculated as 0.91 with SPSS software. Therefore, it can be said that the above questionnaire has sufficient validity.

In this study, first, using the documentary method, basic information about the variables in terms of identifying the variables and the history of research on them were collected. The study population was selected, and finally, using statistical methods, identifying and measuring variables were done by the study sample. In descriptive statistics, data were analyzed by calculating statistical characteristics, such as frequency, frequency percentage, and compiling tables. The Pearson correlation coefficient was used for statistical analysis due to the normality of the data.

3. Results

Out of 265 people studied, most were male employees, with 72.1%. In terms of education, 6% had a diploma and associate degree, 60% had an undergraduate degree, and 34% had a Master›s degree and higher. About 81% of the respondents were married. Among the respondents, 4.9% were among the financial victims of the earthquake, and 1.5 % were among the life victims or other social harms. Also, 75.8% of the participants recognized the role of the vital arteries (energy, water and sewage, road and transportation, and information in the community), and 87.9% considered the interdisciplinary studies of crisis management in the vital arteries as useful.

Analysis of data based on the Pearson correlation coefficient showed that, in general, there is a significant relationship between the classification of vital arteries based on new structuring and crisis management and its key role in crisis control due to earthquakes. Passive defense seems to be the most relevant and important component among the effective approaches in managing vital artery crises. There is a significant relationship (0.715) between passive defense and crisis management of vital arteries. After that, oil and gas transmission pipelines with 0.699 have the most impact (Table 1). According to the explanation and other considerations, the new structure of vital arteries can be presented in the follow discussion.

Table 1. New structure for the classification of vital arteries

Classifications	Correlation of Coefficient	Determination Coefficient	F	Sig.	B	Beta	t	Sig.
Classification of vital arteries based on new structuring	0.60	0.03	2.5	0.006	0.11	0.11	2.2	0.028
Oil and gas transmission lines and other components of vital arteries	0.699			0.002				
The essential role of vital arteries in crisis control and management	0.513			0.0003	Number		265	
The relationship between passive defense and crisis management of vital arteries	0.715			0.002				

4. Discussion

Major crises lead to the stop of many commercial and social activities, which can cause significant harm to communities. Earthquake is one of the natural disasters that cause financial and non-financial losses. Earthquakes are imminent threats to Iran›s urban areas, causing widespread damage and heavy casualties [17]. Earthquake prevention is impossible. However, it is very important to use the lessons learned to reduce the physical and financial damage in similar future events [18]. The results of our research showed that the classification of vital arteries based on the new structuring has a significant relationship with the management of vital arteries crises in accidents and disasters. The vital arteries of cities are the most important components of their economic, social, and even cultural and political stability and dynamism [19].

In analyzing vital arteries, what is important in normal circumstances is their capacity and quality of efficiency for citizens' use. But in the event of natural and man-made crises, the important thing is that the city›s vital arteries be relatively reliable in managing the crisis that has occurred, which largely determines their quality. Vital arteries, as an important infrastructure, play an important role in crisis or earthquake relief.

Vital arteries generally have three important characteristics that distinguish them from buildings and other installations. These three characteristics are as follows. First, they are vast, which causes the vital arteries to be simultaneously affected by several earthquake hazards such as severe shocks, landslides, rockfall, liquefaction, rupture, large and sudden subsidence. Second, the complexity and diversity of components that besides earthquake surveillance, require the close cooperation of various experts in soil and foundation, structure, mechanics, hydraulics, electricity, and telecommunications. This feature also makes the study, evaluation, and behavior of those systems against earthquakes difficult. The exclusivity of some technologies related to the vital artery system and the differences between design and manufacturing standards in the different countries double the problems of this study. Third, harm function interaction, which means that the function of some vital arteries depends on the function of others. Also, damage to some vital arteries can directly or indirectly damage other vital arteries. The studies of Zeidabadi et al. are consistent with our studies in this regard [20].

Our findings showed that in the classification of new vital arteries, passive defense seems to be the most relevant and important component among the effective approaches to the management of vital artery crises, which was consistent with Dabbagh and Al-Madrasi studies [21].

One of the most important measures to increase safety and security in the event of an earthquake is the use of passive defense and crisis management principles to reduce hazards and damage, increase preparedness to deal with, and rebuild and restore life to survivors in earthquake-prone areas. Passive defense does not rely on military weapons, and its implementation can prevent financial and human losses. In other words, any unarmed action that reduces the vulnerability of the country's manpower, buildings, facilities, equipment, documents, and arteries. Also, facilitating crisis management against enemy operations or natural disasters, such as earthquakes, is called passive defense. This defense can be considered any kind of activity in human societies, natural and ecological environments with a protection-oriented and civilian approach. Thus, the purpose of passive defense against natural hazards, such as earthquakes, can meet vital needs, create security, continue services to the public, save lives, facilitate the management of areas in the face of threats and crises to reduce the damage caused by this phenomenon. The results of this study were consistent with the investigations of Hosseini, Askari, and Karami [23-25].

Therefore, regarding the knowledge of infrastructure facilities, a more comprehensive definition of this system seems necessary. According to Namvar studies, the experiences of past earthquakes, such as Bam, show that with the occurrence of moderate earthquakes, the vital arterial systems of the earthquake-stricken region are seriously damaged.

One of the factors that cause damage to vital arteries is the lack of a flexible design for systems that is consistent with our studies [26]. Also, due to the extent and complexity of crisis factors and the importance of social crisis management programs , it is possible to use experts in this field to prepare a social management plan and vulnerability analysis. For the social crisis caused by natural disasters, such as earthquakesand to ensure security in society, it is necessary to deal with the crimes and anomalies that threaten the society and its vulnerability in the short and long term. To reach this important goal, it is possible to enact laws in emergencies and the rapid punishment of criminals and offenders, which Sai-Hong also mentioned in his study [27].

5. Conclusion

The findings of this study showed a significant relationship between the classification of vital arteries based on the new structure and its important role in the resilience of vital arteries in accidents and disasters. Considering the necessity and importance of crisis control, especially in social crises caused by natural disasters, such as earthquakes and damage caused by vital arteries, forming a crisis headquarter, formulating the required strategy, recognizing the crisis and prioritizing, identifying the factors affecting the crisis, choosing appropriate solutions and using appropriate tools, developing education and research and public awareness, controlling crisis and eliminating crisis cases, investigating the consequences of the crisis, retrofitting, and post-crisis intensive caring can be an effective model in crisis management and play an important role in preparedness and response to these accidents and disasters. In this regard, it seems necessary to form a headquarter called the Social Crisis Headquarter based on the required strategies with appropriate and efficient priorities along with the necessary implementation and training.

The results of this study can also help crisis managers in policy-making and planning the issues sensitive to social crisis and considering the role of vital arteries and passive defense in it, countermeasures, and sense of usefulness. Also, problem-solving and empowerment can play a key role in proper and effective management. Having appropriate models based on causal relationships and scientific evidence can prevent many harms to society and improve the health of citizens. Passive defense engineering is one of the least costly preventive measures that can be taken in the golden age of peace, and normal conditions before natural disasters, such as earthquakes, occur. Proper initial locating, observing dispersion, defense and territorial preparing, retrofitting, building safe structures, etc., are among the preventive measures that should be considered before starting the construction of critical and vital facilities and centers.

Ethical Considerations

Compliance with ethical guidelines

There were no ethical considerations to be considered in this research.

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Authors' contributions

All authors equally contributed to preparing this article.

Conflict of interest

The authors declared no conflict of interest.

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