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Identification and ranking of risks caused by natural disasters in terms of sustainable development in the villages of the city

Abstract

The present study aimed to identify and rank the risks caused by natural disasters in terms of sustainable development in the villages of the city of Sar pole Zahab in Kermanshah. The present study is applied in terms of purpose and has been done with a cross-sectional survey approach. The statistical population of this study includes two groups of governorate managers and municipal and Red Crescent staff of Kermanshah province. Using targeted sampling and the snowball method, finally, thirteen experts participated in this study. SWARA method has been used to rank the risks caused by natural disasters. Importance-performance analysis has also been used to assess the importance of risks. The study results showed that the indicators of mortality, treatment costs, and reconstruction costs are the main risks caused by natural disasters in terms of sustainable development, respectively. Based on the results of this study, it is suggested to managers and those involved in crisis management and urban development too, by making the cities more resistant and take passive defense measures, increase the vulnerability of residential areas as much as possible, and thus, reduce the risks threatening lives of citizens.

Keywords: *sustainable development, natural disasters, crisis management, risk management*

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Introduction

Today, sustainable development has become a major management issue all over the world. Planning by governments, allocation of adequate budget, and increased academic research in the field of sustainable development indicate the importance of this issue as the main pillar of management in the third millennium (Vinuesa et al., 2020). Sustainable development became relevant as economic experts sought solutions that could bridge the gap between economically backward and advanced countries more quickly. The economic theories of the advanced world and later the third world was proposed to provide the possibility for the growth of economic indicators such as growth, gross national product, per capita income, employment, and the like. But later the same experts realized that some of the obstacles to economic development are related to social, cultural, and political affairs. So, gradually other dimensions for development emerged and now whenever we talk about development, we mean economic, social, cultural, and political development (Malek Mohammadi et al., 2013).

Natural disasters are considered one of the main obstacles to sustainable development (Robert, K. W et al., 2005). Their occurrence is always an obstacle to economic, social, and civil development. If the severity of the disasters is higher, national development programs will face more difficulties (Torkashvand, 2018). Since 1980, more than two million people have died and more than three trillion Dollars have been lost due to natural disasters, and the total damages due to natural disasters have increased from 23 billion Dollars a year in the 1980s to 150 billion Dollars a year in the last decade. Rapid population growth and urbanization increase the risks of natural disasters. The United Nations estimates that more than two-thirds of the world's population will live in cities by 2050. The World Bank report states that only the damages caused by climatic events (storms, floods, etc.) can damage 1.3 billion people and economically expose 158 trillion Dollars to loss (Lee et al., 2019). Disaster risk management in development planning can reverse the current trend of increased disaster effects. In addition, when countries after a disaster implement reconstruction in a stronger, faster, and more inclusive way, they can reduce the negative effects of disasters on people's livelihoods and health by up to 31% and potentially reduce public damages. If countries act decisively, they can save the lives of people and their properties. However, many developing countries lack the tools, expertise, and instruments required to influence the potential effects of disasters on their investment decisions (Zhang et al., 2018).

Iran is one of the disaster-stricken countries and has been affected by natural disasters in short-term periods. The earthquake in Sarpol-e Zahab, the floods in April 2019 that occurred in many cities and many of their damages have not been repaired yet, the flood in Sistan and Baluchestan, and the like are among the natural disasters that have occurred in Iran in recent years, and the resulting damages have not yet been repaired after several years. Since risk management is a significant part of natural disaster management, in this regard, by conducting more research and identifying the risks arising from natural disasters, guidelines can be provided for managers and decision-makers to take more effective measures to minimize the damage caused by natural disasters. In this regard, the present study aimed to identify and rank the risks caused by natural disasters in terms of sustainable development in the villages of Sarpol-e Zahab in Kermanshah province (Pandit et al., 2017).

Review of literature

Sustainable development

So far, several definitions have been proposed for sustainable development. The most common definition, for example, is given by the Brundtland Commission (1987) in the report entitled "Our Common Future": "Sustainable development is a development that meets the needs of the present without compromising the ability of future generations to meet their own needs". International Union for Conservation of Nature (1991) also defines sustainable development as "sustainable development means increasing the quality of human life within the framework of the tolerable capacity of the supporting ecosystems" (Zand Moghaddam et al., 2019). In the early 1990s, based on the results of various debates about the nature of sustainable development, four basic keywords for sustainable development were introduced which include futurity and future generation, environment, equity, and participation (Alizadeh, 2017). Meanwhile, some researchers have proposed three basic concepts related to sustainability and sustainable development which include nature, life support systems, and community (Olawumi et al., 2018).

There are two key concepts in sustainable development: "what should remain sustainable" and "what should be developed" (Bakkensen,L.A. et al., 2017). According to the existing literature, what needs to be developed includes human beings, economy, and society; and what needs to remain sustainable includes nature, life support, and community(Bourque,L.B et al., 2007). Most early studies in the field of sustainable development have focused on economic development and its dimensions such as the productive economic sector that causes job creation, optimal use of resources, and wealth creation (Caiado et al., 2017).

Natural disasters

Natural disasters are a set of harmful events that have no human origin. These events are usually unpredictable or at least cannot be predicted from a long time ago (Boustan et al., 2020). Nature cannot be controlled, and only by strengthening the infrastructures the severity of vulnerability to natural disasters can be reduced (Pennington et al., 2018). Natural disasters can include earthquakes, hurricanes, floods and tsunamis, landslides, and large-scale fires in war zones that occur in different countries of the world, but some countries have the highest probability of occurrence of natural disasters according to the UN Global Risk Report. These four countries are Japan, the Philippines, China, and Bangladesh, which have experienced a large number of natural disasters in recent years (Cameron and Shah, 2015) (Figure 1).

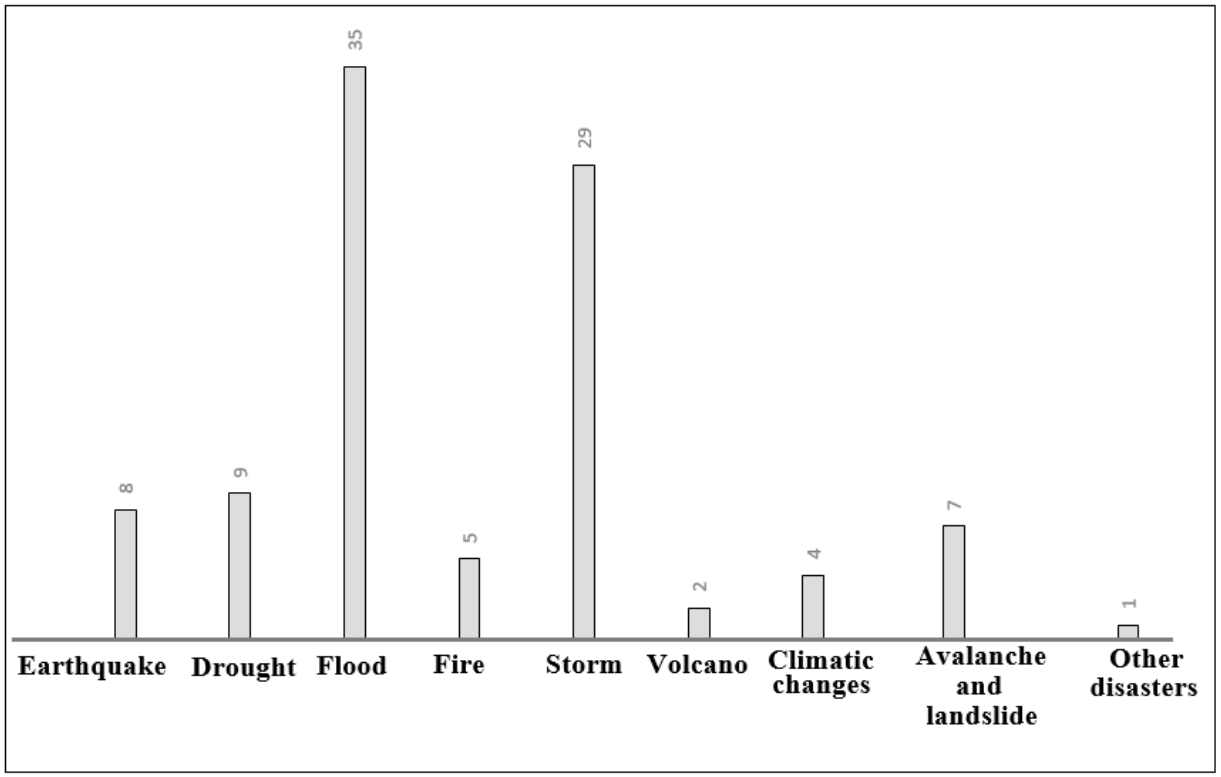

Figure 1. Frequency of natural disasters in the world in the last half-century (values are in percentage; source: Cameron and Shah, 2015)

The most vulnerable regions of the world are located in Africa and Asia, and this vulnerability is due to infrastructural weaknesses in these countries. In terms of the natural disaster risk index in the world, Iran is among the countries with low risk (Pandit,A et al., 2017). However, the probability of a natural disaster in Iran has been reported to be equal to 10.19 percent, while vulnerability to natural disasters has been reported as equal to 46.45 percent. In terms of the global risk index, Iran is in a situation similar to South Korea, Ireland, Moldova, and Lebanon (Daman Keshideh et al., 2016).

Natural disaster risk management

In some countries, after natural disasters, an opportunity is created in which the reconstruction process accelerates development, but in some other countries, the occurrence of natural disasters stops development programs and sometimes causes regression of them (Ranjbar, 2016). Disaster risk reduction is defined as a set of activities reducing disaster risks through systematic analysis and management of disaster causes. These measures include things such as reducing risk exposure, reducing the vulnerability of people and assets, intelligent management of land and the environment, and optimal readiness against damaging events. Risk management is an important part of a disaster risk reduction program (Aitsi et al., 2016). Risk management includes a comprehensive quantitative and qualitative understanding of risk and its associated physical, social, economic, and environmental consequences, and factors. This approach is related to the planning and development of disaster risk reduction strategies and is therefore considered the first necessary step for any discussion of disaster reduction strategies (Zand Moghadam et al., 2019).

Environmental risk assessment is the systematic process of assessing the potential adverse effects of activities and the resulting physical and chemical pollution on humans, plants, animals, and ecosystems in general. In the contemporary era, one of the goals of sustainable development is to achieve economic and social growth according to environmental criteria (Karchani et al., 2014). Although in the event of natural disasters, the damage to human communities is considered more than any other risk, various studies have shown that natural resources are also negatively affected by natural disasters (Cassar et al., 2017; Flint et al., 2005).

In addition, the occurrence of natural disasters in a residential area and social texture destroys many urban and industrial facilities (Hossein, Seyed Hadi et al., 2016), which itself can provide the ground for new environmental risks, including the release of polluting gases, leakage of toxic and dangerous substances into rivers, widespread fire in natural habitats and the like (Rashidi et al., 2014). Among the other risks associated with natural disasters including social risks. Social complexity and information explosion have created severe ambiguities and confusions, and individualism has weakened social control. In such circumstances, the occurrence of natural disasters can have profound and negative effects on society (Jahantigh and Jannat, 2019).

Economic risks are an important part of the risks resulting from natural disasters (Pugatch, T., 2019). Drought, for example, caused a reduction in agricultural production and recession of industry and trade in a country and also affected foreign trade exchanges(Slack,T et al., 2020). Since drought crises occurred on large and small scales and at unknown intervals(Sachs,J.D et al., 2019), the possibility of planning and enacting laws governing funds or revenues for the government was very small (Karimi et al., 2019). The occurrence of natural disasters along with mismanagement and lack of human foresight will lead to negative economic effects such as declining in GDP and shifting of the total supply curve to the left as a negative shock (Azarmi, Somayeh et al., 2018), increased prices of related goods in the short term, and possible spread of widespread and intergenerational poverty in the disaster region (Soltani et al., 2013).

Although social, economic, and environmental risks are among the most important risks associated with natural disasters and are also consistent with central debates on sustainable development (Cruz, A. M et al., 2006), it should be noted that in all definitions of sustainable development (both what should remain sustainable and what should be developed), “Human” is central. On the other hand, the evidence obtained in the last century shows that natural disasters have very catastrophic effects on human lives in such a way that many people have died due to events such as floods, earthquakes, storms, etc. (Cameron and Shah, 2015; Sara B. Weinstein et al., 2018). Accordingly, in the present study, the risks related to human health are considered the fourth dimension of natural disaster risks in terms of sustainable development. Based on the literature review, the conceptual model of research is developed as follows (Figure 2).

Human-health risks **Economic risks**

Social risks	Environmental risks
Criteria	**Indicators**
Human-health	Damage
	Mortality
	Prevalence of diseases
	Psychological damages
Economic	Direct destruction of properties
	Disruption in supply chain
	Disruption in transportation
	Reconstruction costs
	Loss of agricultural resources
	Loss of industrial resources
	Medical expenses
Social	loss of infrastructures
	Destruction of the physical texture of society
	Destruction of cultural heritage
	Decreased communications
	Closure of educational institutions
	Closure of social institutions
Environmental	Emission of pollutants
	Emission of toxic and dangerous substances
	Destruction of natural habitats
	Threatening the life of plants and animals

Figure 2. Conceptual model of research

3. Research method

Research type

The present study is applied in terms of purpose. Also, this study is descriptive research in terms of data collection method and is a cross-sectional survey in terms of data collection time.

Population, sample, and sampling method

The statistical population of this study consists of the two groups of governorate managers and municipal and Red Crescent staff of Kermanshah province. In the factor ranking phase, views of governorate managers have been used. In this study, an expert is a person who has at least 10 years of working experience in the field of natural disaster management and has a Ph.D. degree. Using targeted sampling and the snowball method finally thirteen experts have participated in this study. In the phase of examining the status of the factors also views of the employees of the municipality and the Red Crescent of Kermanshah province have been used. Using the Morgan table, the minimum required sample size was estimated to be 181 people. To be more confident, 200 employees were selected by random sampling method.

Data collection tool

Two questionnaires were used to collect the data. The first questionnaire was provided to the experts to rank the factors. The second questionnaire was a Likert scale questionnaire that was provided to the employees to assess the status of factors. The validity of the questionnaire was confirmed using content validity. Cronbach's alpha of the questionnaire is 0.821; so the questionnaire has good reliability.

Data analysis method

The SWARA method was used to rank and determine the importance of the risks caused by natural disasters. Single-sample T-test was used to assess the status of each factor. Finally, the final results of the study were evaluated using importance-performance analysis.

SWARA method stands for Step-Wise Weight Assessment Ratio Analysis. In the SWARA method, first, the experts arrange the criteria in order of importance. The most important criterion is placed first and gets a score of one. Finally, the criteria are ranked based on the average values of relative importance (Figure 3).

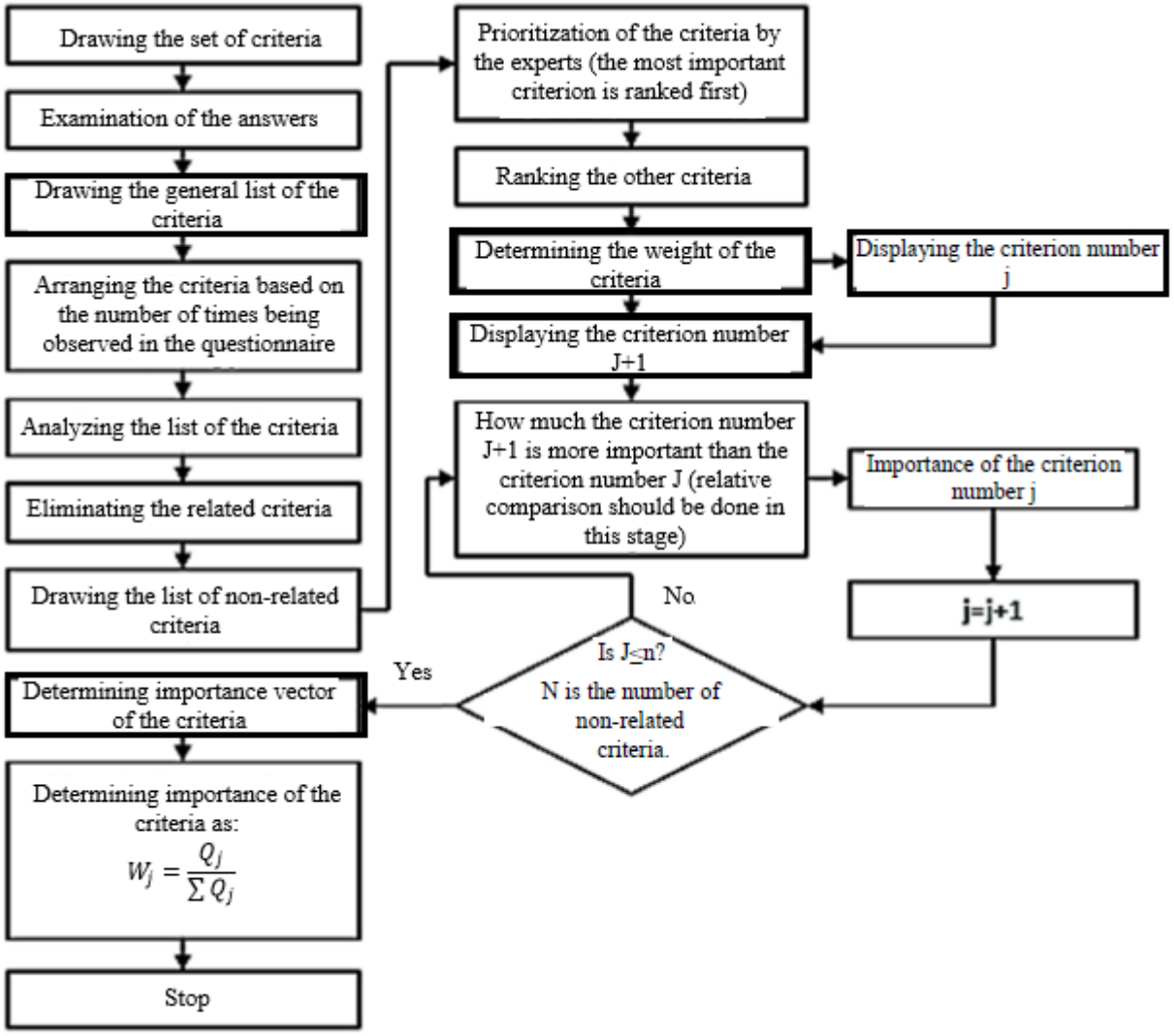

Figure 3. SWARA method steps (Kersuliene et al., 2010)

As mentioned, the main feature of SWARA method is the possibility to estimate expertsor interest groups opinion about significance ratio of the attributes in the process of theirweights determination. It has been proven that for a successful selection of a rational dispute resolution method, an alternative multi-attribute assessment can be applied. The multi-attribute system based on SWARA could be applied in practical implementation of specialized decision support systems and alternative dispute resolution in a virtual environment.

First step: Prioritizing the criteria

First, the considered criteria are written in order of importance. The most important criteria are in the higher categories and the less important criteria are in the lower categories.

Second step: Determining the relative importance of each criterion (S_j)

In this step, the relative importance of each criterion compared to the previous criteria is determined. In the SWARA method process, this value is shown by S_j.

Third step: Calculating the coefficient of K_j

The coefficient of K_j which is a function of the relative importance of each criterion is calculated using Equation 1:

$K_j = S_j + 1$

Fourth step: Calculating the initial weight of each criterion

The initial weight of the criteria is calculated using Equation 2. In this equation, it should be noted that the weight of the first criterion, which is the most important criterion, is considered equal to 1.

$$Q_j = \frac{Q_{j-1}}{K_j}$$

$Q_j = Q_{j-1} / K_j$

Fifth step: Calculating the final normal weight

In the last step of the SWARA method, the final weight of the indicators which is also considered the normalized weight is calculated using Equation 3. Normalization is done through the simple linear method.

$$W_j = \frac{Q_j}{\sum Q_j}$$

As mentioned, the main feature of the SWARA method is that it is possible to evaluate the opinions of experts or assessment teams about the importance of the indicators in the process of determining their weight.

4. Results of Research

SWARA method has been used to rank the risks caused by natural disasters. First, the risks caused by natural disasters are arranged in order of importance. Then, the relative importance of each criterion compared to the previous criteria is determined. These values are inserted in the "Average Relative Importance" column of the table, which is the same S_i.

In the third step of the SWARA method, the coefficient of K_i is calculated. The coefficient of K_i for the first index which is the most important is one. This value is also calculated for other risks caused by natural disasters. To calculate the initial weight of each criterion, the following equation is used:

$$Q_i = \frac{Q_{i-1}}{K_i}$$

$$Q_1 = 1$$

$$Q_2 = \frac{Q_1}{K_2} = \frac{1}{1.16} = 0.862$$

$$Q_3 = \frac{Q_2}{K_3} = \frac{0.862}{1.31} = 0.658$$

$$Q_4 = \frac{Q_3}{K_4} = \frac{0.658}{1.05} = 0.627$$

These values are inserted in the "Initial Weight" column of the table. To calculate the final weight, the linear normalization method is used according to the following equation:

$$W_i = \frac{Q_i}{\sum Q_i}$$

In this way, the final weight of each element is obtained (Table 1).

Table 1. Prioritization of risks using the SWARA method

Criterion code	Average relative importance	Kj	Initial weight	Normal weight
S01	1	1	1	0.148
S02	0.16	1.16	0.862	0.128
S03	0.31	1.31	0.658	0.097
S04	0.05	1.05	0.627	0.093
S05	0.19	1.19	0.527	0.078
S06	0.27	1.27	0.415	0.061
S07	0.11	1.11	0.374	0.055
S08	0.05	1.05	0.356	0.053
S09	0.09	1.09	0.326	0.048
S10	0.12	1.12	0.291	0.043
S11	0.21	1.21	0.241	0.036
S12	0.18	1.18	0.204	0.03
S13	0.25	1.25	0.163	0.024
S14	0.18	1.18	0.138	0.02
S15	0.31	1.31	0.106	0.016
S16	0.04	1.04	0.102	0.015
S17	0.11	1.11	0.092	0.014
S18	0.21	1.21	0.076	0.011
S19	0.09	1.09	0.069	0.01
S20	0.013	1.013	0.068	0.01
S21	0.09	1.09	0.063	0.009
Total			6.757	1.000

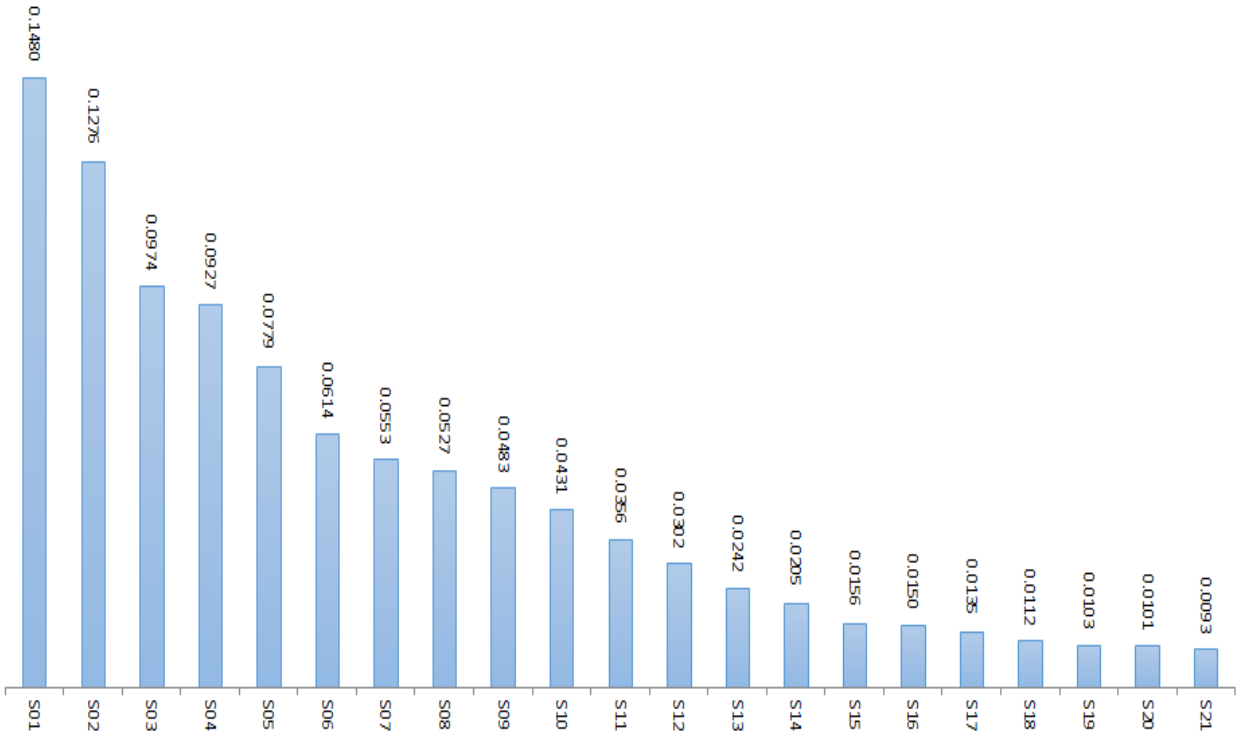

Figure 4. The final weight of the risks caused by natural disasters through the SWARA method

A mortality index with a weight of 0.148 is the priority.
The medical expenses index with a weight of 0.128 is the second priority.
The reconstruction costs index with a weight of 0.097 is the third priority (Figure 4).

Importance-Performance analysis

After identifying the importance of each of the risks caused by natural disasters, a single-sample t-test was used to assess the status of these variables. The results of this test (performance) along with the results of SWARA (importance) for each indicator in the present study were examined from two perspectives. The important aspect is represented by me and the performance aspect is represented by P. Since the separate analysis of the data of performance dimension and important dimension, especially when each data set is studied simultaneously, may not be significant, so, the data related to the level of importance and performance of the indicators are shown on a two-dimensional network in which the y axis indicates importance dimension and the x-axis indicates performance dimension ((Figure 5). This two-dimensional network is called the importance-performance matrix or IP matrix.

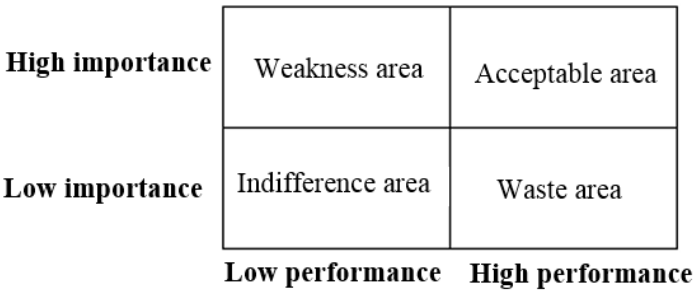

Figure 5. Outline of Importance-Performance Matrix (IPA)

Four quarters can be identified based on how much important each indicator is (optimal status) and how well is performed in the field of this indicator (current status):

- Indifference area: low performance- low importance
- Waste area: high performance- low importance
- Weakness is: low performance- high importance
- Acceptable area: high performance- high importance

The result of the importance-performance evaluation for indicators of the present study is as follows:

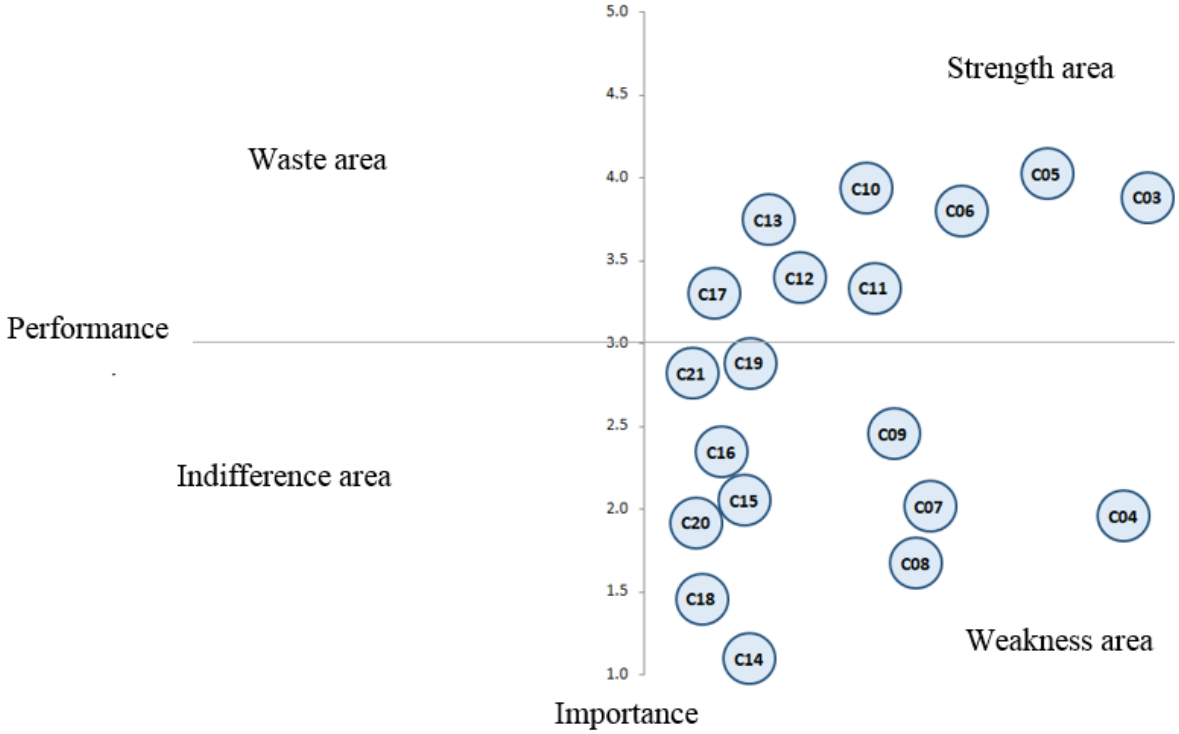

Figure 6. Importance-Performance Assessment (IPA) result

According to the study results, all research indicators are important, so there is no indifference area and waste area. On the other hand, performance is low in some cases and desirable in others; so, the indicators are in the "weakness area" and "acceptable area". Two main categories of indicators can be distinguished in (Figure 6). Strength area, meaning the indicators that are at a desirable level in terms of performance, include indicators 3, 5, 6, 10, 11, 12, 13, and 17. Weakness area, meaning the indicators that are at an undesirable level in terms of performance and importance, include indicators 4, 7, 8, 9, 14, 15, 16, 18, 19, 20, and 21.

5. Conclusion and practical suggestions

Based on the results obtained from risk ranking, it was found that the mortality index has the highest priority. The fact is that occurrence of natural disasters has a devastating effect on human health and life more than any other factor. Evidence from the last 50 years clearly shows what catastrophic events occurrence of natural disasters has had in terms of human destruction (Pennington et al., 2018). On the other hand, it was found that medical expenses are in the second rank in terms of importance. Medical expenses caused by the occurrence of natural disasters or human actions have always been proposed as an important issue in crisis management and involve a large part of economic problems caused by the occurrence of disasters (Jalili, 2012).

According to the obtained results, reconstruction costs and transportation disruptions are among the other risks caused by natural disasters, which are in the third and fourth ranks. These categories of risks are under economic risks, and as stated in various studies, economic considerations are considered among very important issues in the management of the crises caused by natural disasters (Boustan et al., 2020; Daman Keshideh et al., 2016).

In the present study, the risks related to human life and health were considered as a fourth category of the risks related to natural disasters. Based on the results obtained from IPA analysis, these risks are also recognized as important. In this regard, it should be noted that sustainable development has essentially been proposed aiming to provide life and well-being for humans (Azadeh et al., 2019), and therefore, it is not surprising that humans have a pivotal role in sustainable development programs(Jahangir, Ebrahim et al., 2015).

A noteworthy point about the results obtained in this study is that human-health risks and economic risks, in general, were more important than economic and environmental risks. These findings can be interpreted based on the available evidence regarding the occurrence of natural disasters in the country. This means that what was more visible in recent years about natural disasters in Iran was the high mortality rate as well as severe economic crises after the occurrence of catastrophic natural disasters among which the Bam earthquake and Kermanshah earthquake can be mentioned.

Ethical statement

This paper is original and has not submitted elsewhere.

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Conflict of interest

The authors have no conflicts of interest to declare**.**

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