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Identifying and Prioritizing Factors Influencing Flood Crisis and Proposing Possible Strategies Using Delphi Techniques and Analytic Hierarchy Process (Case Study: Crisis Management in Ahvaz County)

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Abstract:

In recent decades, new preventive methods have been developed to combat flooding. By implementing specific urban land-use plans, enacting regulations and laws, and educating the public, flood damage can be minimized. This approach avoids the heavy costs of constructing capital-intensive flood control facilities. The aim of this research is to identify and prioritize the factors influencing flood crises and propose possible strategies using Delphi techniques and the Analytic Hierarchy Process (AHP) (case study: crisis management in Ahvaz County). This research is applied in terms of its goal and descriptive-exploratory in nature, based on data collection methods using the Delphi approach.

The statistical population consists of experts, senior experts, and managers who form the crisis management team in Ahvaz County. Given that the statistical population comprises 20 individuals, a purposive sampling method was employed. Participants must have the following characteristics: 1) specialization in crisis management and information management, 2) a specified organizational structure, and 3) inclusion of senior managers and experts within the organization.

The methodology of this research is based on, first, a comprehensive understanding of the concepts and identification of the dimensions and components of the research problem. This was achieved through consultations with professors, managers, and previous research, leading to the identification of critical factors in the application of information technology in crisis management. These factors were compiled into a questionnaire distributed among experts.

In the final step, the selected criteria were compared using pairwise comparison tables (pairwise comparison questionnaire), and the resulting data served as the basis for multi-criteria decision-making and AHP to prioritize the top criteria. The analysis of the research questions and questionnaires was conducted using EXPERT CHOICE and SPSS software. The prioritization of factors influencing the flood crisis indicates that support management and human resources have the highest importance and priority from the experts' perspective. Subsequent priorities include organizational structure and specialized equipment.

Keywords: Flood crisis, organizational structure and specialized equipment, support management and human resources

Introduction

Floods are one of the natural disasters that cause significant damage to people and communities annually. A flood early warning system ensures that the end-users receive timely and appropriate warnings, allowing them to take necessary actions to protect their assets and minimize damage. The occurrence of heavy and torrential rains, typical of arid and semi-arid regions, leads to floods. Such rainfall results from a combination of synoptic and environmental conditions. The passage of Mediterranean cyclones is the primary cause of torrential rains in Iran (Zarei & Valipour, 2020).

Iran's Mediterranean climate and the temporal and spatial concentration of rainfall in most watersheds lead to massive floods, causing extensive human and financial losses. Other countries also face this natural disaster, and responses vary depending on government policies. For example, Japan's policies include maximizing floodwater storage for water use. This approach focuses on utilizing floodwaters as water resources. In Iran, despite limited water resources in most watersheds, flood mitigation policies focus on designing and operating hydraulic structures to discharge floodwaters without causing downstream damage (Sani, 2018).

Flooding has long been a natural phenomenon observed by humans. Due to its vast area, diverse climates, and temporal and spatial concentration of rainfall in most watersheds, Iran annually experiences significant floods in many regions (Mahdavi Nia, 2019).

A crisis manager must possess multiple skills, including technical, human, and conceptual abilities. Essential crisis management skills include public relations and communication, advertising, dealing with public opinion, high-level coordination and leadership, technical rescue operations, inter-agency coordination, and quick and accurate decision-making (Pazuki & Sabouri, 2020).

In recent decades, new methods to combat flooding have been developed, focusing more on prevention than treatment. Implementing specific urban land-use plans, regulations, and public education can reduce and minimize flood damage while avoiding the high costs of flood control infrastructure (Enayati & Givehchi, 2020).

This study aims to identify the factors influencing flood crises and propose possible strategies through documentary research. The goal is to integrate crisis management into urban planning, preventing floods, reducing rainfall damage, and promoting optimal use of rainwater in various dimensions. Thus, this research seeks to answer the following questions: What are the factors influencing flood crises in Ahvaz County, and what are the possible strategies to prevent flood crises?

Addressing urban environmental crises is a challenge faced by many cities. Flooding is a severe risk affecting many countries, recognized globally as one of the most severe natural disasters among the 15 types of natural calamities. Population pressure and the lack of agricultural land have driven human migration to floodplains, exacerbating floods and their destructive effects. Structural methods for flood protection, such as levees and other flood management structures, can be effective but come with high design capacity requirements and residual risk when they fail. Often, these structures may be unsuitable or infeasible due to environmental reasons, necessitating non-structural methods. Flood warnings are crucial for managing residual risk and are one of the most effective non-structural flood management methods.

A comprehensive plan that understands the causes and factors influencing natural disasters and their consequences, while also considering the natural interaction and connectivity of different regions and the change in land use of major water resources, is essential to prevent the recurring cycle of natural disasters like floods in the country.

Climate change, global warming, and resulting droughts are significant contemporary global challenges causing extensive fluctuations in Earth's climatic conditions. These fluctuations lead to substantial changes in weather patterns (e.g., precipitation distribution and weather phenomena), resulting in prolonged droughts, soil erosion, desertification, dust storms, and environmental degradation. Climate change's impacts include global warming, altered rainfall patterns, increased torrential rains, changing precipitation from snow to rain, and ultimately, influencing flood occurrence. Urbanization and vegetation removal reduce water infiltration and increase surface water, enhancing flood magnitude and sediment erosion, which reduces riverbed capacity (Mahdavi Nia, 2019).

In Khuzestan, surface water collection is the municipality's responsibility, while wastewater management falls under the water and sewerage organization. However, there is no surface water collection system in this province, except in some areas with systems built by the British, such as Newside, the Oil Town, etc. These areas have systems for easy drainage of rainwater to rivers. The absence of surface water collection channels causes water to move towards sewage channels, which also have numerous issues. In Ahvaz and other Khuzestan cities, the concrete or asbestos sewage pipes lack flexibility, leading to problems such as subsidence, especially closer to the sea, where groundwater levels are higher. These pipes often suffer from subsidence and cracking due to ground layer compaction, causing sewage leakage into groundwater (Mahdavi Nia, 2019).

The provincial crisis management director, operating under the governorate, must oversee the availability of necessary crisis management equipment, procure required items if needed, and

ensure proper flood crisis management by identifying influencing factors and proposing possible strategies. This enables responsible organizations, especially crisis management, the water and sewerage company, and Ahvaz municipality, to make appropriate decisions to reduce flood crises.

Research Objectives

1. Identify factors influencing flood crises in Ahvaz County.
2. Weight the factors influencing flood crises in Ahvaz County.
3. Prioritize factors influencing flood crises in Ahvaz County.
4. Propose possible strategies for flood crisis management.

Practical Objectives

The primary beneficiaries of this research are crisis management managers, experts, and practitioners in Ahvaz County. Additionally, managers and experts from the governorate, the water and sewerage company, and Ahvaz municipality can benefit from these findings.

Research Questions

1. What are the factors influencing flood crises in Ahvaz County?
2. What is the weight of each factor influencing flood crises in Ahvaz County?
3. How are the factors influencing flood crises in Ahvaz County prioritized?
4. What are the possible strategies for flood crisis management?

Methodology

To ensure the validity of the research results, a suitable methodology must be employed, as incorrect methodology leads to incorrect conclusions. This chapter discusses the research methodology, statistical population, and sample, as well as the statistical methods used for data analysis, concluding with the presentation of analytical results and the research model.

The methodology of this research is based on several steps. Initially, to understand the concepts fully and identify the dimensions and components of the research problem, experts, managers, and previous studies on factors affecting flood crises were consulted using the Delphi technique through a Delphi questionnaire. In the subsequent step, selected criteria were compared using pairwise comparison questionnaires (Analytic Hierarchy Process - AHP). The data obtained from these tables form the basis for multi-criteria decision-making and AHP to prioritize the

top criteria. For AHP and questionnaire analysis, EXPERT CHOICE and SPSS software were utilized.

3.2 Research Process

In this study, the required measures for each variable are first identified through a literature review and the Delphi approach. Then, expert opinions are reviewed, followed by the preparation of pairwise comparison questionnaires to determine the importance of each criterion. Subsequently, the AHP matrix is completed, and finally, the criteria are ranked using the AHP method. The research steps are as follows:

1. Library research
2. Expert opinions using the Delphi technique
3. Preparation of pairwise comparison questionnaires to determine the importance of each criterion
4. Completion of the AHP matrix
5. Ranking using the AHP method

3.3 Research Method

This research is applied in terms of its objective. In terms of data collection methods, it is a descriptive-exploratory study utilizing the Delphi approach.

3.4 Statistical Population and Sample

The statistical population consists of individuals or units with at least one common trait (Sarmad et al., 2012). The definition should be comprehensive, covering all units of study spatially and temporally, while excluding irrelevant units (Khaki, 2003). In this research, the statistical population includes experts, senior experts, and managers forming the crisis management team in Ahvaz County. An expert is defined as someone with extensive knowledge, appropriate expertise, and relevant skills in the research field.

3.4.1 Sampling Method

Purposive sampling means the researcher selects individuals and study locations that can significantly contribute to understanding the research problem and central phenomenon. This strategy requires decisions about:

1. Whom and what to sample?
2. What type of sampling to use?
3. How many individuals or locations to sample?

The sample in this study consists of 20 individuals from the crisis management field. The purposive sampling criteria include:

1. Specialization in crisis management and information management,
2. Specific organizational structure,
3. Inclusion of senior managers and experts.

3.5 Data Collection Methods and Tools

Methods:

Data collection is a critical part of any research project. Proper and systematic data collection leads to accurate analysis and conclusions. Data collection methods are divided into library and field research. Library research is used for literature review and background information, while field research is used to validate or refute research questions.

- **Library Research:** Various sources such as documents, books, articles, magazines, microfilms, computer disks, and CDs are used for data collection (Hafez Nia, 2003). In this study, books, articles, journals, theses, and the internet were extensively used for the literature review.
- **Field Research:** A common field data collection tool is the questionnaire, which allows extensive data collection. Questionnaires evaluate knowledge, interests, attitudes, opinions, previous experiences, and current practices of individuals (Sarmad et al., 2012).

Tools:

Data collection tools in this research include semi-structured interviews and questionnaires.

1. Interviews:

- Interviews, whether conducted in person or remotely, involve asking predetermined questions. Flexibility in interviews varies based on the type, with semi-structured interviews allowing exploration of new ideas based on interviewee responses. Semi-structured interviews are used in the first round of the Delphi technique.

2. Questionnaires:

- Questionnaires are widely used for data collection in survey research. They consist of targeted questions utilizing various scales to assess the opinions, views, and insights of respondents. This research uses Likert scale-based questionnaires for the Delphi technique and pairwise comparison questionnaires based on Saaty's nine-point scale for AHP.

3.6 Data Analysis Method

The research methodology involves several steps. Initially, concepts and dimensions of the research problem are understood through consultations with professors, managers, and existing studies. Critical factors in the use of information technology in crisis management are identified and compiled into a questionnaire distributed among experts. The final step involves comparing selected criteria using pairwise comparison tables (pairwise comparison questionnaire). The resulting data form the basis for multi-criteria decision-making and AHP to prioritize the top criteria. EXPERT CHOICE and SPSS software are used for analyzing research questions and questionnaires.

3.7 Delphi Method

"Two minds are better than one," especially in anticipating the future and making informed decisions. The Delphi technique is a structured process for forecasting and decision-making through rounds of surveys, data collection, and ultimately group consensus. While most surveys answer "what is," Delphi addresses "what can/should be" (Ahmadi et al., 2008).

Delphi Method Steps:

1. Identification of experts
2. Round one: Semi-structured interviews

3. Analysis and feedback
4. Round two: Refinement and additional feedback
5. Consensus and final recommendations

3.8 Pairwise Comparisons

The AHP methodology is based on pairwise comparisons. After forming the decision hierarchy tree, elements in each level are compared pairwise relative to elements in higher levels. In group decision-making using AHP, each individual completes pairwise comparison matrices based on the AHP tree. These matrices are aggregated using the geometric mean if the consistency rate is appropriate. The pairwise comparisons and scoring are based on Saaty's standardized scale. This process includes pairwise comparison tables for options relative to criteria and criteria relative to each other. After respondents complete the matrices, group scores are calculated using geometric means (Millet et al., 2000).

3.9 Ethical Considerations

Ethical considerations were observed during the data collection process, including:

1. Explaining the research objectives to participants,
2. Obtaining informed consent from participants,
3. Protecting respondent information.

Questionnaires assured participants of anonymity, ensuring no identifiable information could be traced back to individual respondents.

Results

The results of this study are presented using both descriptive and inferential statistics. The descriptive statistics section provides an overview of the sample's demographic characteristics, while the inferential statistics section discusses the findings from the Delphi technique and Analytic Hierarchy Process (AHP) analysis.

Descriptive Statistics

Descriptive statistics involve organizing, summarizing, and graphing the collected data to understand the sample characteristics.

Gender of Respondents

The data collected from the questionnaires show that out of the total sample, 70% (14 individuals) were male, and 30% (6 individuals) were female.

Table 1: Gender of Respondents

Gender	Frequency	Percentage
Male	14	70%
Female	6	30%
Total	20	100%

Educational Level

Most respondents hold a bachelor's degree, followed by those with master's degrees or higher, indicating a well-educated sample.

Table 2: Educational Level of Respondents

Education Level	Frequency	Percentage
Associate Degree or Lower	0	0%
Bachelor's Degree	12	60%
Master's Degree or Higher	8	40%
Total	20	100%

Age of Respondents

The majority of respondents are aged between 41 and 50 years, indicating a sample of experienced individuals.

Table 3: Age of Respondents

Age Group	Frequency	Percentage
Under 30	0	0%
31-40	2	10%
41-50	14	70%
Over 50	4	20%

Total	20	100%
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Work Experience of Respondents

Most respondents have 16 to 20 years of work experience, highlighting their expertise.

Table 4: Work Experience of Respondents

Work Experience	Frequency	Percentage
Less than 10 years	0	0%
11-15 years	6	30%
16-20 years	9	45%
21-25 years	4	20%
Over 25 years	1	5%
Total	20	100%

Delphi Technique Results

The Delphi technique was used to identify and screen the most critical decision-making criteria. The results from each round are summarized below.

Round Three

Table 5: Descriptive Statistics for Round Three

Criterion	Sub-criterion	Frequency	Mean	Std Dev
Support and Manpower Management	Low experience of human resources	20	3.40	1.49
	Insufficient accommodation equipment	20	3.05	1.50
	Incompetence of managers and staff	20	3.05	1.47
	Insufficient medical supplies	20	3.10	1.37
	Insufficient vital supplies	20	2.60	1.47
	Untrained human resources	20	2.80	1.47

	Lack of specialized training	20	2.20	1.32
	Responsibility	20	3.70	1.53
	Disruption of normal life	20	3.00	1.21

Table 6: Statistical Tests in Round Three

Test	Value
Number	20
Kendall's W Test	0.816
Chi-Square	24.235
Degrees of Freedom	20
Significance	0.022

The results from the third round indicated that Kendall's coefficient of concordance ($W=0.816$) was greater than 0.8, suggesting overall agreement among experts regarding the sub-criteria. Therefore, the Delphi process was concluded.

Analytic Hierarchy Process (AHP)

The AHP method was applied to prioritize the factors influencing the flood crisis.

Pairwise Comparisons for Support and Manpower Management

Table 7: Decision Matrix for Support and Manpower Management

Sub-criteria	Weight
Low experience of human resources	0.338
Insufficient accommodation equipment	0.162
Incompetence of managers and staff	0.111
Insufficient medical supplies	0.073
Responsibility	0.207
Disruption of normal life	0.110

Figure 1: Prioritization of Sub-criteria for Support and Manpower Management

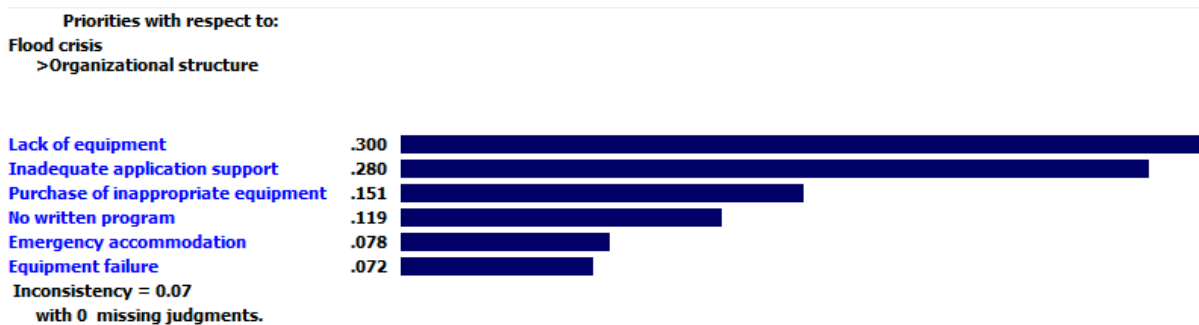


Pairwise Comparisons for Organizational Structure and Equipment

Table 8: Decision Matrix for Organizational Structure and Equipment

Sub-criteria	Weight
Inadequate emergency accommodation	0.078
Inadequate program support	0.280
Inappropriate equipment purchase	0.151
Lack of written programs	0.119
Lack of light and heavy equipment	0.300
Equipment failure	0.072

Figure 2: Prioritization of Sub-criteria for Organizational Structure and Equipment

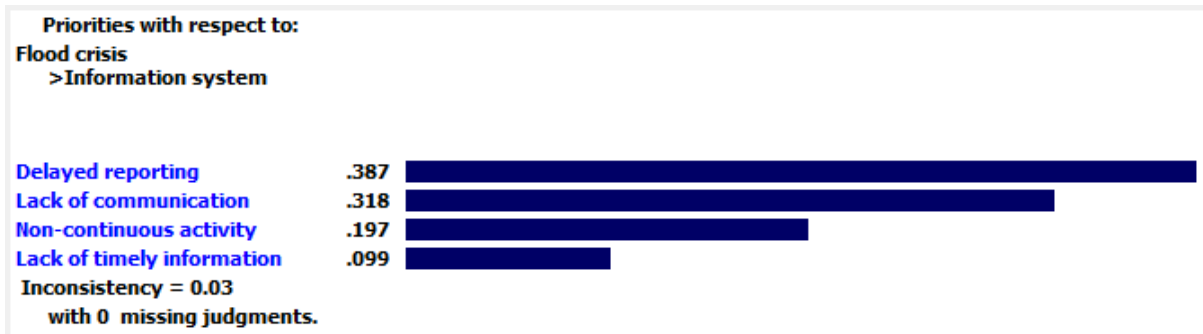


Pairwise Comparisons for Information System

Table 9: Decision Matrix for Information System

Sub-criteria	Weight
Non-continuous activity	0.197
Lack of communication infrastructure	0.318
Delayed reporting	0.387
Lack of timely information	0.099

Figure 3: Prioritization of Sub-criteria for Information System

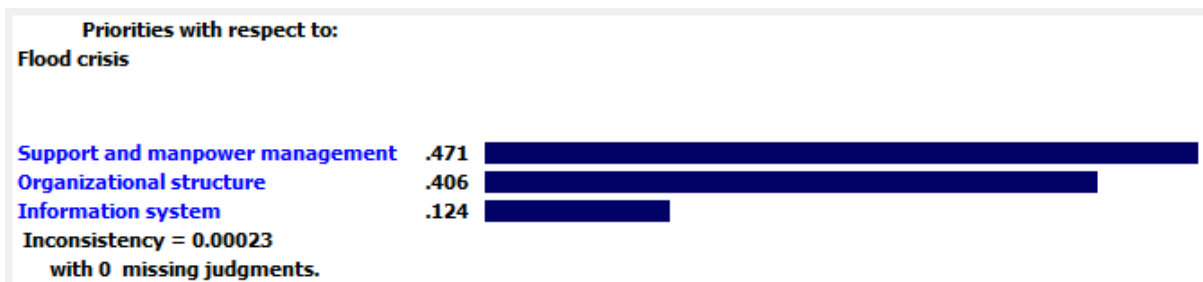


Overall Pairwise Comparison of Criteria

Table 10: Decision Matrix for Overall Criteria

Criteria	Weight
Support and Manpower Management	0.471
Organizational Structure and Equipment	0.406
Information System	0.124

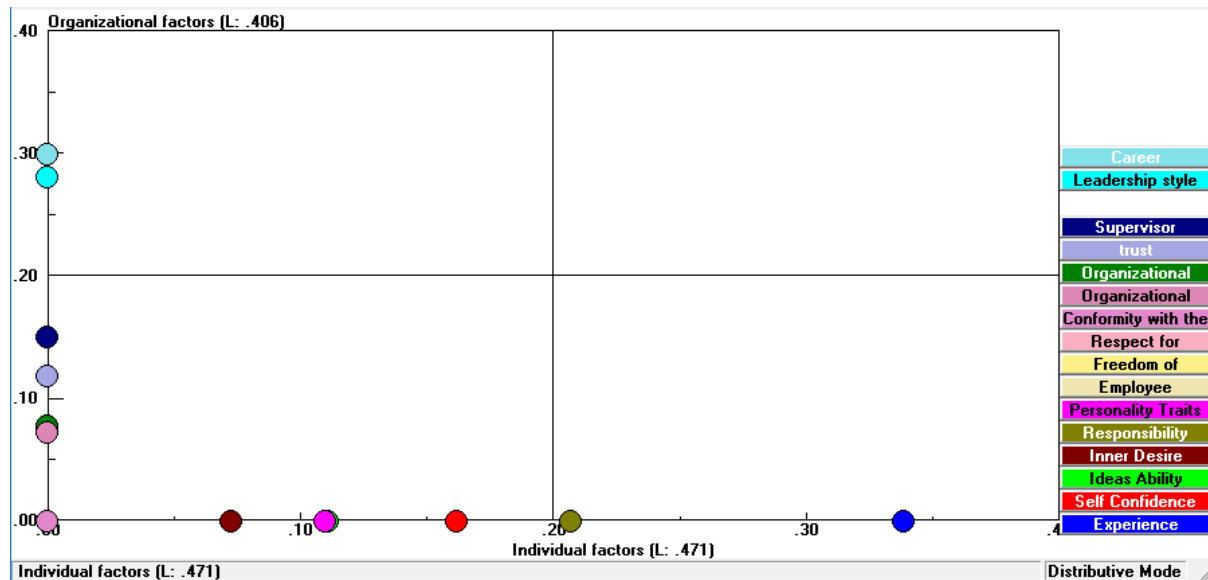
Figure 4: Prioritization of Overall Criteria



Sensitivity Analysis

Sensitivity analysis evaluated the robustness of the results against changes in criteria weights.

Figure 5: Sensitivity Analysis Based on Efficiency Relative to Overall Goal



Conclusion

Until a few years ago, crisis management was an unfamiliar term, but it has now become an integral part of public relations activities. This is due to the numerous responsibilities that public relations departments have, both internally and externally. Public relations within an organization function as a communication medium during crisis management, handling both internal and external communications. The concept of crisis management emerged following significant events in the late 1980s, which highlighted the need for systematic approaches to handle crises. Crisis management is still considered a relatively new field, focusing primarily on media control and the application of systematic observation and analysis to prevent crises or mitigate their effects when they occur.

The primary objective of this research was to identify and prioritize the factors influencing flood crises and propose possible strategies using Delphi and Analytic Hierarchy Process (AHP) techniques, specifically within the context of crisis management in Ahvaz. The findings revealed that there are several key factors affecting flood crises. Through previous research and expert input, three main criteria were identified: support and manpower management, organizational structure and specialized equipment, and the information system.

Using AHP, these factors were prioritized, with support and manpower management emerging as the most critical factor with a weight of 0.471, followed by organizational structure and specialized equipment (0.406), and the information system (0.124).

Future Work

Based on the findings of this research, several recommendations and areas for future work are proposed:

1. Ethical Considerations in Crisis Response:

- Ensure fairness among aid recipients, maintain composure and avoid anger during relief efforts, provide help selflessly, avoid personal use of resources, and uphold ethical behavior in all interactions. Prevent unethical behaviors such as excessive demands for unnecessary aid, theft of victims' property, and inappropriate conduct during crisis situations.

2. Promoting Participatory Approaches:

- Effective crisis management requires a bottom-up participatory approach. Promoting a culture of participation and decentralization is essential for a dynamic and effective crisis management system.

3. Enhancing Crisis Management Skills:

- Many current crisis managers lack essential crisis management skills. It is crucial to ensure that crisis managers possess multiple competencies, including public relations, communication, leadership, technical rescue operations, inter-agency coordination, and rapid decision-making abilities.

4. Proactive Crisis Intervention:

- Uncontrolled crises tend to escalate. Early intervention is crucial to prevent crises from becoming unmanageable. Managers must have access to adequate resources to address crises promptly.

5. Integrating Crisis Management into Strategic Planning:

- Managers should view crisis management as an integral part of their strategic responsibilities, reducing the likelihood of their organizations falling into crises. Emphasizing the connection between crisis management and technical and operational planning is vital.

Research Limitations

This study faced several limitations that should be considered:

- The generalizability of results is limited to the crisis management context in Ahvaz, and caution should be exercised when applying these findings to other settings or organizations.
- The findings should be cautiously extrapolated to other time periods and contexts.

Recommendations for Future Research

- Future researchers are encouraged to explore the evaluation of flood risk factors caused by human activities using Geographic Information Systems (GIS).
 - Investigate the role of specific determinants of flood crises in urban management.
 - Examine the factors contributing to urban flooding and the role of management in mitigating these effects.
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