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# Identifying and Prioritizing Barriers Influencing Humanitarian Supply Chain During Disasters: A Best-Worst Method

H. Gheibdoust, M. Homayounfar*, A. Kiani-Sarkaleh, M. Soufi

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**Abstract** The humanitarian supply chain (HSC) plays a vital role in mitigating the devastating effects of natural disasters such as earthquakes and floods in Iran; however, it faces numerous operational barriers that reduce its effectiveness. Despite the growing body of literature on HSC, there remains a lack of empirical studies that systematically prioritize these barriers in disaster contexts using robust multi-criteria decision-making approaches, particularly in developing countries. Addressing this gap, the present study aims to identify and prioritize the key barriers affecting the HSC during disasters in Iran using the Best–Worst Method (BWM). Data were collected through structured questionnaires administered to 21 experts from the Rasht Red Crescent Society. The identified barriers were classified into four main dimensions: financial, human, technological, and cultural, comprising 12 sub-barriers. The findings reveal that financial barriers, especially the lack of skills in resource utilization and high disaster-related costs, exert the most significant impact on HSC performance. Human and technological barriers were ranked next, while cultural barriers were found to be the least influential. These results provide scientifically grounded insights that contribute to the HSC literature and offer practical guidance for policymakers and managers by highlighting the importance of sustainable financing, human resource development, and the adoption of digital technologies to enhance HSC resilience in disaster-prone environments.

**Keyword:** Humanitarian, Supply Chain, Humanitarian Supply Chain, Disasters, Best-Worst Method.

## 1 Introduction

In recent years, the scale and complexity of humanitarian assistance in response to crises have increased significantly. In 2020 alone, approximately 85 million people were displaced due to war, conflict, and large-scale emergencies, while global crises such as the COVID-19 pandemic further intensified humanitarian needs by severely straining health systems worldwide [1]. Natural disasters such as earthquakes and floods remain inherently unpredictable, and despite

* **Corresponding Author.** (✉)
**E-mail:** homayounfar@iau.ac.ir (M. Homayounfar)

**H. Gheibdoust**
Department of Industrial Management, Ra.C., Islamic Azad University, Rasht, Iran

**M. Homayounfar**
Department of Industrial Management, Ra.C., Islamic Azad University, Rasht, Iran

**A. Kiani-Sarkaleh**
Department of Electrical Engineering, Ra.C., Islamic Azad University, Rasht, Iran

**M. Soufi**
Department of Industrial Management, Ra.C., Islamic Azad University, Rasht, Iran



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significant scientific and technological advances, human societies are still unable to prevent their occurrence [2]. Consequently, effective disaster response requires a well-coordinated supply chain (SC) capable of delivering goods and services in a timely and reliable manner to mitigate the devastating impacts of such events.

Following disasters, humanitarian operations typically involve numerous governmental and non-governmental organizations providing relief to affected populations, which substantially increases the complexity of coordination and resource allocation within the SC [3, 4]. Disruptions to SC may arise from various sources, including natural disasters and global crises, leading to severe economic, operational, and logistical challenges [5, 6]. In this context, humanitarian supply chain management (HSCM) focuses on the coordination and oversight of relief-related flows from their points of origin to final beneficiaries, with the primary objective of supporting populations affected by emergencies and disasters [7]. HSCM plays a pivotal role in reducing human suffering by ensuring the efficient movement of relief materials, information, and resources between aid providers and affected communities. Core operational activities of HSCM include procurement, storage, inventory management, transportation, and distribution of humanitarian aid, all of which must be carried out under conditions of urgency, uncertainty, and infrastructure disruption [8, 9]. These characteristics distinguish humanitarian supply chain (HSC) from commercial SC and underscore the importance of systematically identifying and managing the barriers that hinder their performance during disasters.

Despite the growing body of literature on HSC, limited empirical studies have systematically prioritized the barriers affecting HSC during disasters using robust multi-criteria decision-making approaches, particularly in developing-country contexts such as Iran. This gap is especially critical given Iran's high vulnerability to natural disasters and the operational challenges faced by humanitarian organizations. To address this gap, the present study aims to identify and prioritize the key barriers influencing the HSC during disasters in Iran. To achieve this objective, the Best–Worst Method (BWM), a structured multi-criteria decision-making technique based on expert judgment, is employed to derive reliable and consistent priority weights. The study offers a novel, evidence-based prioritization framework that enhances the scientific understanding of HSC barriers and provides actionable insights for policymakers and managers to strengthen the resilience and effectiveness of humanitarian operations.

The rest of this paper is organized as follows. Section 2 provides a review of the relevant literature, research background, and influential barriers and sub-barriers. The research methodology is presented in Section 3. Section 4 presents the research findings. Section 5 is devoted to the discussion, and finally, Section 6 is devoted to the conclusion of the paper.

## 2 Literature review

### 2.1 Disasters

A disaster is an event that profoundly impacts society, causing widespread devastation to human lives, the environment, infrastructure, wildlife, and economic systems [10]. Since the 1980s, the global frequency of disasters has nearly doubled, with developing nations facing the greatest challenges due to limited resources and inadequate infrastructure for preparation and response [11]. Disasters are categorized into natural (e.g., earthquakes, floods arising from unstable natural energy) and man-made (e.g., resulting from negligence or systemic failures) types [12]. Preventing or precisely predicting primary natural disasters remains challenging due to technological limitations, emphasizing the importance of risk assessments that integrate



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historical data for pre-disaster preparedness and protection [13]. Recent studies have developed models to enhance humanitarian logistics in disasters. For instance, Matam and M [14] proposed a relief distribution framework that aids crisis managers in decision-making during emergencies. Similarly, Wang and Sun [15] introduced a multi-period emergency material allocation model, demonstrating its effectiveness in distributing supplies for large-scale sudden natural disasters.

### 2.2 Humanitarian

In recent years, humanitarian needs have risen sharply due to the increasing frequency and severity of natural disasters. Despite this growing demand, financial resources for humanitarian aid are often insufficient to meet the needs of affected populations [16]. Humanitarian logistics refers to the structured systems and processes that coordinate the mobilization of personnel, resources, and expertise to support communities affected by disasters. Its main goal is to deliver aid efficiently, ensuring resources reach the right place at the right time [17].

Humanitarian disasters characterized by loss of life, food and water shortages, infrastructure destruction, and population displacement are occurring at an alarming rate. To address these crises, NGOs often collaborate with government agencies, private companies, and multinational organizations to implement coordinated response efforts [18]. Research highlights several factors critical to effective humanitarian operations. Akter et al. [19] identified key enabling capabilities, including analytical culture, technological advancement, data-driven insights, autonomous decision-making, and continuous training. Konrad et al. [20] noted operational challenges in conflict zones, such as security threats, unpredictable transport routes, and fluctuating demand. Kadir et al. [21] emphasized the importance of integrating early childhood development interventions into emergency health responses for children.

### 2.3 Humanitarian supply chain

A SC is a network of organizations including suppliers, manufacturers, distributors, and customers working together to produce and deliver goods. Challenges such as insufficient information, limited traceability, and a lack of trust among stakeholders can undermine its efficiency. Effective data management is essential to ensure reliability and quality throughout the SC [22, 23]. Global crises, such as the COVID-19 pandemic and the Ukraine conflict, have exposed the vulnerability of SC, significantly affecting humanitarian programs worldwide [24]. Disasters impact human lives, economies, and the environment, causing destruction and forced displacement. HSCM ensures the timely delivery of critical resources such as food, water, shelter, and medical supplies to those in need [7].

The HSC operates as a linear network, connecting donors, humanitarian organizations, suppliers, and logistics partners. Efficient coordination among these actors is essential, especially during disasters or social unrest, to ensure rapid and accurate aid delivery [25]. HSCs are inherently vulnerable, requiring flexibility and sustainability to maintain resilience and responsiveness [26]. The main goal of HSC is to maximize aid to affected populations, guided by non-profit principles [27]. Key HSC activities include strategic planning, inventory management, storage, procurement, and distribution. Advanced logistics infrastructures improve agility and efficiency, enhancing the effectiveness of aid delivery and beneficiary satisfaction [28]. Core operations HSC involve assessing needs, mobilizing resources, and ensuring timely distribution of both tangible and intangible assets [29]. Methodological studies



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highlight challenges and opportunities in humanitarian research. Kovacs and Moshtari [30] outlined considerations for conducting reliable studies in disaster contexts. Altay et al. [31] emphasized that innovation in HSC is an emerging area, requiring more field-based research and expert involvement. Patil et al. [32] explored barriers to sustainability in humanitarian health SC, illustrating their social and environmental impacts. Table 1 summarizes the main barriers and sub-barriers in HSC.

**Table 1** Barriers and sub-barriers to HSC in the face of disasters

| Barrier | Sub-barrier | Definition | Reference |
|---|---|---|---|
| Financial barriers (C1) | High cost during disasters (C11) | During disasters, communities face difficulties in securing consumer goods, which drives up prices. | [33, 34] |
| | Lack of resource management skills (C12) | Lack of skills and experience in spending financial resources to serve affected populations during disasters. | [35] |
| | Lack of donor support (C13) | A large volume of humanitarian aid is provided by donors, and in the absence of this aid, humanitarian organizations face numerous challenges in securing funding. | [36] |
| Technological barriers (C2) | Lack of IT infrastructure (C21) | Lack of proper infrastructure leads to lack of use of emerging technologies. | [32, 33, 36] |
| | Lack of technology use (C22) | Lack of technology in humanitarian SC and use of traditional SC instead of mechanized SC. | [35] |
| | Lack of IT personnel (C23) | With the increasing use of information technology in most organizations, the shortage of human resources specialized in the field of information technology is one of the main problems in most organizations. | [33] |
| Human barriers (C3) | Unethical Behaviors (C31) | Behavior that goes against social norms and is considered unacceptable by the public. | [37, 34] |
| | Lack of Staff Training (C32) | Effective training improves business compliance, reduces costly errors, increases performance and job satisfaction, and fosters collaboration. | [34, 33] |
| | Lack of Volunteers or Human Resources (C33) | Community quarantines can lead to a shortage of human volunteers in communities, which can be best managed with proper planning. | [8] |
| Cultural barriers (C4) | Cultural differences between actors (C41) | The High Committee is composed of people from diverse cultural backgrounds. Lack of familiarity with the culture of the High Committee actors can jeopardize the work of the High Committee. | [36] |
| | Creating a culture of social responsibility (C42) | Social responsibility is an ethical theory in which individuals are accountable for their civic duty and an individual's actions should benefit the community as a whole. | [38] |
| | Purpose-oriented culture (C43) | In a goal-oriented culture, individuals identify with what is being done. The focus is on achieving specific internal goals or outcomes. | [33] |


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## 3 Methodology

This study used a descriptive survey design to achieve its objectives. The study was conducted in collaboration with the Rasht Red Crescent Society. Data were collected in person from May to August 2024, depending on the availability of participants. In this study, a systematic literature review was conducted using the Scopus and Web of Science databases from 2015 to 2024. Keywords including "humanitarian supply chain", "disaster logistics", "humanitarian supply chain performance" and "disaster management" were used to identify barriers and sub-barriers to the HSC. To ensure the content validity and contextual applicability of the identified drivers, the initial framework was subsequently reviewed by a panel of 21 experts from the Red Crescent Society. All experts had more than a decade of operational experience in the Red Crescent Society, were fully familiar with the structure and activities of the Red Crescent Society, and were experienced in disaster relief. A structured review process was conducted using assessment checklists and semi-structured interviews to collect feedback on the clarity, relevance and completeness of the proposed barriers, which were hierarchically structured into four main dimensions and 12 distinct sub-dimensions, based on provided an analysis for the application of BWM. Subsequently, this multi-criteria decision-making (MCDM) technique was used to derive weighted priorities among the identified HSC barriers and sub-barriers. The influential HSC barriers were confirmed through expert consensus. After the experts reached consensus on the influential HSC drivers, they were asked to prioritize them using the BWM questionnaire. A short training session ensured that the participants understood the process of completing the BWM form.

The aggregation of pairwise comparisons from multiple experts was performed using the geometric mean, as it is a standard approach in group BWM for handling multiplicative preferences and reducing bias in ratio-based data. This method is theoretically grounded in multiplicative aggregation theory, ensuring consistency in uncertain environments by preserving the relative scales of comparisons, unlike the arithmetic mean, which may distort ratios. It was applied to the best-to-others and others-to-worst vectors to derive aggregated inputs for the optimization model [39]. The geometric mean is calculated as:

$$\left(\prod_{i=1}^{n} a_i\right)^{1/n} = \sqrt[n]{a_1\, a_2\, a_3 \dots a_n} \tag{1}$$

The collected data were analyzed using LINGO 18 software to determine the optimal weights and compatibility ratios. The data collection process involved a structured questionnaire specifically designed for BWM. The questionnaire included closed pairwise comparison questions based on the BWM framework. Experts were asked to identify the most important (best) and least important (worst) drivers and sub-drivers within each set. Pairwise comparison values were calculated using the 1 to 9 were provided for both the best-to-others and the worst-to-others comparisons [40]. In this study, 21 experts were willing to cooperate. The questionnaires were given to the experts in person. MCDM methods rely on the judgment of experts, so a large number of respondents are not required to complete the questionnaire [41, 42, 43]. Therefore, the use of 21 qualified experts ensures robust and reliable model outputs and goes beyond the standard sample requirements in the literature. Experts were selected using purposive sampling. This sampling method is used in MCDM methods that require experts' opinions to answer the questionnaire. For this reason, the use of purposive sampling was widespread in management studies.



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### 3.1 Best-Worst Method (BWM)

The BWM, introduced by Rezaei [44], is a pairwise comparison-based technique designed for determining criteria weights in MCDM problems. This method is notable for its efficiency, requiring significantly fewer pairwise comparisons than traditional comparison-based approaches [45]. BWM can be employed independently to derive criteria weights or integrated with other MCDM methodologies to enhance decision-making processes. The BWM method is recognized as one of the important approaches in MCDM. BWM evaluates options through expert opinions and ranks them from best to worst. Initially, experts rank the options from best to worst and assign weights to each, indicating their perceived merit. The weights are calculated based on the difference between the best and worst options [40]. The Best-Worst Method (BWM) was selected for this study due to its advantages over traditional MCDM methods, particularly in the context of HSC during disasters. Unlike techniques such as Analytic Hierarchy Process (AHP), which require a full set of pairwise comparisons (leading to potential inconsistencies and higher respondent burden), BWM only necessitates *2n-3* comparisons for *n* criteria, making it more efficient and less time-consuming for experts in high-pressure environments like disaster management [44]. In HSC, where decisions must be made under uncertainty, resource constraints, and time sensitivity, BWM provides consistent and reliable weights by minimizing inconsistencies through its optimization model [46]. Additionally, its use in comparable situations, such as identifying the key barriers to SC resilience (e.g., Patil et al., [32]), shows that it is effective in analyzing complex and interdependent factors in Iran's disaster-prone environment. This approach guarantees effective prioritization, allowing policymakers to improve the efficiency of HSC operations. The procedural steps of the BWM, as outlined by Rezaei [47], provide a structured and streamlined approach to weight assignment, making it a valuable tool in MCDM applications. The procedural steps and formulation of the BWM in this study are adapted from Aryafar and Roshanravan [45], based on the linear model proposed by Rezaei [47].

**Step 1.** A set of effective decision-making factors $\{DC_1, DC_2, \dots, DC_n\}$ that are used to achieve the set goal are identified.

**Step 2.** The worst factor (the least important) and the best factor (the most important) are identified by the decision-makers. No comparison is made at this stage, and the worst and best decision factors are identified only by the decision-makers.

**Step 3.** By assigning a value in the range of 1 to 9, decision-makers indicate their preference for the most beneficial criteria to other criteria. This creates a row vector known as the best-to-others (BO) expressed in Equation (2).

$$A_B = (a_{B1}, a_{B2}, a_{B3}, \dots, a_{Bn}) \tag{2}$$

In the above vector, $a_{Bj}$ demonstrates the precedence of the best decision criterion B over the decision criterion *j*. It is explicit that $a_{BB} = 1$.

**Step 4.** By assigning a value in the range of 1 to 9, decision-makers indicate their preference for the other criteria, considering the least profitable criteria. This creates a row vector known as the other to worst (OW) shown in Equation (3).

$$A_W = (a_{1W}, a_{2W}, a_{3W}, \dots, a_{nW})^T \tag{3}$$

In the above vector, $a_{jW}$ demonstrates the precedence of the decision criterion *j* over the worst decision criterion *W*. It is explicit that $a_{WW} = 1$.



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**Step 5.** The optimal weights $(W_1^*, W_2^*, W_3^*, \ldots, W_n^*)$ are computed by solving the optimization problem shown in Equations (4).

$$\begin{aligned} \min \quad & \xi \\ s.t. \quad & \left|W_B - a_{Bj}W_j\right| \le \xi \qquad \text{for all } j \\ & \left|W_j - a_{jw}W_w\right| \le \xi, \qquad \text{for all } j \\ & \xi\, W_j = 1 \\ & W_j \ge 0, \qquad for\ all\ j \end{aligned} \tag{4}$$

The computed value for the ξ* (uncertainty parameter) and their respective consistency index (CI) in Table (2) can be used in Equation (5) to calculate the consistency ratio (CR).

**Table 2** The consistency Indices (CI)

| $a_{BW}$ | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
|---|---|---|---|---|---|---|---|---|---|
| **Consistency index (*max* ξ)** | 0.00 | 0.44 | 1.00 | 0.63 | 2.30 | 3.00 | 3.73 | 4.44 | 5.23 |

$$CR = \frac{\xi^*}{CI} \tag{5}$$

CR values typically range from 0 to 1. CR values close to 1 denote high inconsistencies whereas values close to 0 depict high consistencies. Thus, during decision-making based on the BWM, pairwise comparisons created with CR values close to 0 are the most preferred.

## 4 Finding

In this study, the impact of barriers on HSC for crisis management was assessed using the BWM method. First, barriers and sub-barriers of the HSC were identified, and then experts were identified to prioritize the barriers and sub-barriers. The best barriers and sub-barriers and the worst barriers and sub-barriers were identified by the experts. Then, decision-makers indicated their preference for the best barriers and sub-barriers over the other barriers by assigning values in the output from 1 to 9. Then, the questionnaires were merged using the geometric mean method. Also, the experts indicated their preference for the other barriers and sub-barriers over the least important barriers and sub-barriers. Then, the weights of the barriers and sub-barriers were obtained using the LINGO 18 software, and the pairwise comparison consistency rate was less than 0.1, which is acceptable.

**Table 3** Ranking of barriers and sub-barriers to HSC in the face of disasters using the BWM method

| Barrier | Weight | Sub-barrier | Weight | Rank | Final weight | Rank |
|---|---|---|---|---|---|---|
| Financial barriers | 0.5564 | High cost during disasters (C11) | 0.6973 | 2 | 0.3879 | 2 |
| | | Lack of resource management skills (C12) | 0.8135 | 1 | 0.4526 | 1 |
| | | Lack of donor support (C13) | 0.2212 | 3 | 0.1230 | 7 |
| Technological barriers | 0.1773 | Lack of IT infrastructure (C21) | 0.7070 | 2 | 0.1253 | 6 |
| | | Lack of technology use (C22) | 0.8528 | 1 | 0.1512 | 4 |
| | | Lack of IT personnel (C23) | 0.2076 | 3 | 0.0368 | 11 |



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| | | | | | | |
|---|---|---|---|---|---|---|
| **Human barriers (C3)** | 0.1917 | Unethical Behaviors (C31) | 0.6755 | 3 | 0.1294 | 5 |
| | | Lack of Staff Training (C32) | 0.2352 | 2 | 0.0450 | 10 |
| | | Lack of Volunteers or Human Resources (C33) | 0.8916 | 1 | 0.1709 | 3 |
| **Cultural barriers (C4)** | 0.0744 | Cultural differences between actors (C41) | 0.6804 | 2 | 0.0506 | 9 |
| | | Creating a culture of social responsibility (C42) | 0.2344 | 3 | 0.0174 | 12 |
| | | Purpose-oriented culture (C43) | 0.8511 | 1 | 0.0633 | 8 |

Table 3 shows the ranking of barriers and sub-barriers of HSC in the face of disasters using the BWM method. This table presents the weights within each dimension and the final weight, along with the ranking. The results of prioritizing barriers show that financial barriers, with a weight of 0.5564, were assigned the most importance among other barriers, which emphasizes the financial challenges in the HSC in Iran. After that, human and technology barriers were ranked second and third with weights of 0.1917 and 0.1773, respectively, and cultural barriers with a weight of 0.0744 were ranked fourth among other barriers to the HSC, which indicates that experts pay little attention to it. Also, the sub-barriers of lack of resource management skills and high cost during disasters ranked first and second with weights of 0.4526 and 0.3879, respectively, which indicates their high importance in this study. These sub-barriers are related to financial barriers, which further emphasizes the importance of financial barriers. After that, the sub-barrier of lack of volunteers or human resources ranked third with a weight of 0.1709, which indicates its importance among other sub-barriers of the HSC in the face of disasters. The sub-barrier of creating a culture of social responsibility ranked last, which indicates its low importance among other sub-barriers, and this sub-barrier is related to cultural barriers, which itself ranked last. According to Table 3 and Figure 1, the remaining sub-barriers were also each assigned a rank.

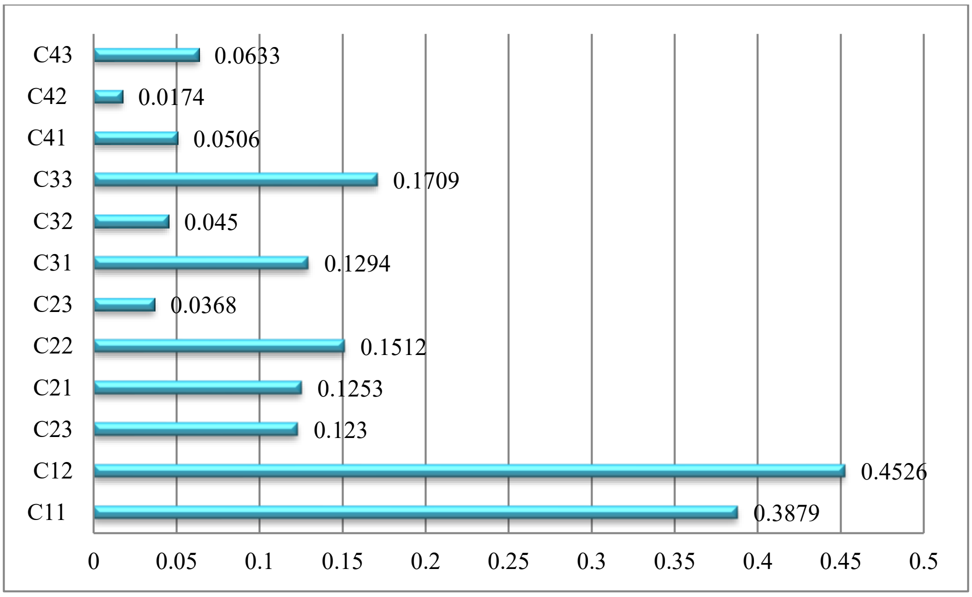


**Fig. 1** shows the values of the sub-barriers with their weight values


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### 4.1 Sensitivity analysis

To assess the robustness of the final ranking results, a sensitivity analysis was conducted by adjusting each expert’s pairwise comparison values by ±5%. This adjustment simulates potential variations in expert judgments due to uncertainty in disaster management contexts. The recalculated weights and rankings are presented in 4.1 Sensitivity Analysis (Table 4). The results indicate that small changes in expert judgments do not significantly alter the ranking order of the main drivers or sub-drivers, confirming the stability of the BWM-based prioritization.

**Table 4** Sensitivity analysis of barriers rankings

| Barriers | Original Weight | Rank (Original) | Weight (+5%) | Rank (+5%) | Weight (−5%) | Rank (−5%) |
|---|---|---|---|---|---|---|
| **Financial (C1)** | 0.5564 | 1 | 0.5842 | 1 | 0.5285 | 1 |
| **Technological (C2)** | 0.1773 | 3 | 0.1861 | 3 | 0.1684 | 3 |
| **Human (C3)** | 0.1917 | 2 | 0.2012 | 2 | 0.1821 | 2 |
| **Cultural (C4)** | 0.0744 | 4 | 0.0781 | 4 | 0.7006 | 4 |

## 5 Discussion

The findings of this study demonstrate that financial barriers are the most critical constraints affecting HSC performance during disasters in Iran. This result reflects the broader economic and operational challenges faced by humanitarian organizations, where limited funding availability and inefficiencies in financial resource utilization hinder timely and effective disaster response. Unlike other barriers, financial constraints affect multiple SC functions simultaneously, thereby exerting a disproportionate influence on overall performance.

The prominence of the lack of resource management skills indicates that effective financial governance is as important as funding availability itself. This finding is consistent with earlier studies emphasizing managerial and organizational limitations in humanitarian logistics [48], while further highlighting the need for targeted financial planning and control mechanisms in disaster response operations. Human-related barriers ranked second, underscoring the essential role of skilled personnel and volunteers in the HSC. The shortage of trained human resources can significantly reduce operational efficiency, particularly in last-mile distribution and coordination activities. This observation aligns with prior research [34, 49] and suggests that investment in continuous training and volunteer management systems is crucial for improving preparedness and responsiveness. Technological barriers were identified as less influential than financial and human factors, although their role remains important for enhancing coordination and information flow. Limited adoption of digital tools and insufficient IT infrastructure constrain the potential benefits of technology-enabled humanitarian logistics, as also noted in previous studies [33]. Finally, cultural barriers were the least important among the main barriers. The sub-barrier “creating a culture of social responsibility” ranked last in this dimension, which may be due to the study's focus on operational and logistical aspects rather than social and cultural factors. This result differs somewhat from the studies of Kabra et al. [36], who emphasized the role of cultural factors, such as trust between stakeholders. In the Iranian context, the culture of solidarity and assistance during disasters is traditionally strong, but this study suggests that strengthening this culture through continuous training and awareness campaigns can help improve social participation in the HSC.

In summary, the results suggest that strengthening HSC in disaster-prone regions requires prioritizing financial management capabilities and human resource development, while progressively integrating digital technologies to support long-term resilience and coordination.

## 6 Conclusion

This study used the BWM method to identify and prioritize barriers affecting the HSC during disasters in Iran and provided valuable insights for improving the efficiency of this chain in crises. The results of this research provide a practical framework for policymakers and managers to strengthen the resilience of the HSC against natural disasters such as earthquakes and floods by focusing on key barriers. From a policy perspective, this study guides policymakers towards developing macro-policies for sustainable financing. Establishing national emergency funds with government support and strengthening international cooperation could facilitate access to the financial resources needed for relief operations, especially as Iran faces economic constraints due to international sanctions and currency fluctuations. In addition, establishing joint national committees involving government institutions, NGOs, and local communities could improve coordination among stakeholders. Such policies should emphasize transparency in resource allocation and establish mechanisms to leverage international donor support to enhance the effectiveness of the HSC. From a managerial perspective, HSC managers, especially in organizations such as the Red Crescent Society, should focus on developing human capacity and technological infrastructure. Designing regular training programs for volunteers and staff, with an emphasis on crisis management and logistics skills, can improve the ability to respond quickly and effectively to disasters. Also, investing in digital technologies, such as cloud-based inventory management systems or logistics tracking platforms, can enhance operational coordination and reduce inefficiencies. Effective management of this chain requires standardization of procedures at all stages, from procurement to distribution, which can be achieved through integrated management protocols. Strengthening collaboration with local communities to recruit and train volunteers can also increase operational capacity in times of crisis.

The BWM method has proven its effectiveness in this study as a powerful tool for decision-making in complex and uncertain HSC environments. The results of this study can serve as a guide for policymakers and managers in Iran and other developing countries with similar conditions. By focusing on sustainable financing, human capacity development, and the use of new technologies, the resilience of the HSC can be strengthened, and the devastating effects of disasters can be minimized. The limitation of the present study is the number of 21 experts used in this study. Although this number is sufficient for the BWM method and in line with literature standards, the focus on a specific region (Rasht) may limit the generalizability of the results to the entire country of Iran or other regions with different geographical and cultural characteristics.

For future research, it is suggested that this approach be combined with other methods, such as interpretive structural analysis (ISM), to examine the relationships between barriers more deeply and provide more comprehensive solutions for HSCM.



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