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ARTICLE

Enhancing Resilience and Sustainability in Humanitarian Procurement: A Supplier Evaluation Framework Using the Best-Worst Method

Ei Myat Kay Khine[1] · Huay Ling Tay[2] · Hui Shan Loh[2]

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Abstract
With the growing complexity and frequency of humanitarian crises globally, incorporating resilience and sustainability criteria into the supply chains of humanitarian organizations has become essential. This study aimed to enhance the resilience and sustainability of the humanitarian supply chain by integrating economic, resilience, environmental, and social aspects. The Delphi method was employed as the research method, and the best-worst method (BWM) was applied to compute the context-specific supplier evaluation criterion weights. As an outcome of this research, the current and desirable supplier evaluation criteria were identified, and a holistic supplier evaluation framework was developed for humanitarian organizations (HOs). The study revealed that the integration of environmental criteria in supplier evaluation is still in its emerging stage. Moreover, increasing stakeholder engagement and securing donor support are critical for achieving resilience and sustainability in humanitarian procurement. This study provides an easy step-by-step supplier evaluation process that can be applied by HOs to enhance sustainable and resilient humanitarian procurement.

Keywords Best-worst method · Decision support systems · Humanitarian procurement · MCDM · Supplier evaluation criteria · Supply chain resilience and sustainability

1 Introduction

Humanitarian operations focus on alleviating disaster-related suffering, in contrast with the economic objectives of commercial organizations (The Logistics Institute 2019). Procurement lies at the heart of humanitarian response. Unlike commercial procurement, humanitarian procurement must evaluate suppliers not only on economic and sustainability criteria but also on their ability to operate under extreme uncertainty, respond to sudden demand surges, and maintain continuity during crises (Merminod et al. 2014). Poor supplier selection can have immediate life-or-death consequences for reasons from delayed medical supplies to unsafe goods (Moshtari et al. 2021). Therefore, effective supplier evaluation, selecting the best supplier from a prequalified pool using predefined criteria, is critical to building resilient and sustainable supply chains. To address growing aid demands, humanitarian organizations (HOs) must optimize these processes, including facility location and logistics planning under disaster-related uncertainties (Heng et al. 2025) and researchers and practitioners need innovative methods for identifying efficient and effective suppliers (Rezaei 2019; Hu et al. 2022; Tay et al. 2025a; Tay et al. 2025b). This study develops a practical framework to support these objectives.

Sustainable supplier evaluation involves considering suppliers' capabilities, willingness to cooperate, and contextual factors, alongside economic, environmental, and social dimensions of sustainability (Rezaei 2019), while also accounting for resilience in humanitarian logistics systems to reduce disaster losses and support long-term recovery (Ye et al. 2025). In recent years, sustainability has been increasingly linked with resilience, resulting in sustainable and resilient supplier selection problems (Liao et al. 2023; Duan et al. 2025). Multidimensional indicator-based frameworks have proven effective in assessing deprivation and inequality across developing nations (Khokhar et al. 2024). Similarly, sustainable development research in emerging economies found that multiple

✉ Huay Ling Tay
hltay@suss.edu.sg

[1] Centre for Applied Research, Singapore University of Social Sciences, Singapore 599494, Singapore

[2] School of Business, Singapore University of Social Sciences, Singapore 599494, Singapore

organizational and strategic factors need to be integrated to drive long-term growth (Raza et al. 2024). This trend reflects a growing focus on creating supply chains that are both environmentally conscious and robust to uncertainties such as economic shifts, natural hazards and disasters, or pandemics (Fallahpour et al. 2021). Resilience refers to a supply chain's ability to respond, recover, and renew following a disruption (Adobor and McMullen 2018), thereby reducing risks and uncertainties (Stewart et al. 2009) as evidenced in sustainable-resilient humanitarian logistics models (Ghaebi Panah et al. 2025). Therefore, a sustainable supply chain must first be resilient, and resilient supplier evaluation should focus not on new criteria but on reprioritizing existing criteria.

However, traditional sustainable supplier selection approaches often prioritize sustainability criteria while neglecting resilience considerations (Amindoust 2018). This underscores the need to develop a multicriteria evaluation framework that integrates both sustainability and resilience in humanitarian procurement. Despite their importance, the combination of these concepts in the context of supplier selection is rare (Venkatesh et al. 2019; Fallahpour et al. 2021). Supplier selection is fundamentally a multicriteria decision-making (MCDM) problem in which suppliers are evaluated against conflicting criteria (Memari et al. 2019; Afrasiabi et al. 2022). Research on sustainable supply chains relies heavily on quantitative MCDM methods, which evaluate multiple criteria simultaneously (Govindan et al. 2015; Evcïoğlu 2023). Structured evaluation frameworks have been increasingly applied to assess sustainability performance across supply chain operations (Liao et al. 2023; Tay and Foo 2026). Among them, the best-worst method (BWM) has distinct advantages, including requiring fewer pairwise comparisons than traditional methods and ensuring greater consistency (Munim et al. 2022; Beinabadi et al. 2024; Koç et al. 2024). The BWM has been applied in various research fields in MCDC studies, such as the sustainability evaluation of supply chains (Sadjadi and Karimi 2018; Kusi-Sarpong et al. 2019; Pamučar et al. 2020; Duan et al. 2025). Moreover, BWM has been applied to evaluate social sustainability criteria in manufacturing supply chains (Khokhar, Hou, et al. 2020); (Khokhar, Iqbal, et al. 2020), assess green-resilient supplier selection (Hailiang et al. 2023), and measure sustainability maturity in humanitarian logistics operations (Ozceylan and Tanyas 2025).

This study addresses the gap by developing a holistic framework that integrates supplier evaluation criteria (SECs) across economic, resilience, environmental, and social dimensions in different situations. The study considers humanitarian procurement in four contexts: non-emergency procurement (NEP) of goods and services (for missions such as steady-state development programs, pre-disaster prepositioning, and post-disaster rebuilding) and emergency procurement (EP) of goods and services (for missions such as disaster relief with high levels of urgency).

Methodologically, it applies the BWM to derive consistent and reliable weights for supplier evaluation criteria, offering a structured yet adaptable decision-making approach. Unlike existing studies, this research explicitly distinguishes between emergency and non-emergency procurement contexts, enabling more context-sensitive prioritization of criteria. In doing so, the study contributes to both theory and practice by advancing a more nuanced and operationalizable approach to humanitarian supplier evaluation. The research questions are as follows:

Research Question (RQ) 1 What are the weighted critical SECs for humanitarian procurements in non-emergency and emergency contexts?

Research Question (RQ) 2 How can these weighted SECs be applied by HOs in decision making via the best-worst method-based supplier evaluation framework?

Research question 1 aims to identify the critical weighted SECs for procuring goods and services in non-emergency and emergency humanitarian contexts. Based on these results, Research question 2 proposes a multicriteria supplier evaluation framework (SEF) and systematic approach for ranking SECs via the BWM.

The structure of this article is as follows. Section 2 reviews the relevant literature on humanitarian procurement, resilience and sustainability criteria in the supply chain, and the BWM. Section 3 outlines the methodology. Section 4 presents the findings and proposes the BWM-based SEF. Section 5 concludes the article.

2 Literature Review

This literature review examines the key concepts underpinning humanitarian procurement and supplier evaluation, with particular attention to sustainability, resilience, and procurement decision making. It reviews how supplier evaluation criteria have evolved across humanitarian contexts and highlights the growing need to balance economic, resilience, social, and environmental considerations. Together, these studies provide the foundation for understanding how supplier evaluation priorities may differ between non-emergency and emergency humanitarian operations.

2.1 Humanitarian Procurement

Humanitarian procurement faces a wide range of challenges, from technical issues and inadequate coordination to normative obstacles such as localization. Challenges such as

coordination difficulties and limited access significantly hinder the effective delivery of aid to those most in need and result in increased operating costs, resource waste, and, in the worst case, the death of people (Agarwal et al. 2020; Masoomi et al. 2023). Many of these challenges are well discussed in the humanitarian literature, with numerous scholars focusing on specific challenges that recur across different contexts (Bollettino et al. 2024). In humanitarian procurement, supplier evaluation plays a crucial role in both development programs and disaster response. While procurement for development typically follows standardized lead times, resembling commercial practices (Kovács and Spens 2009; Falasca and Zobel 2011; Kern 2021), humanitarian procurement demands responsiveness and material positioning, especially for sudden-onset crises (Falasca and Zobel 2011; Venkatesh et al. 2019). Procurement activities are often divided into development aid, which involves continuous sourcing by nongovernmental organizations (NGOs), and relief efforts focused on saving lives by sourcing inexpensive, locally available items (Falasca and Zobel 2011).

While development procurement is more bureaucratic and time-consuming (Bhusiri et al. 2021; Moshtari et al. 2021), relief operations require flexibility, often bypassing tendering processes to meet urgent needs (Moshtari et al. 2021). This flexibility may compromise cost efficiency and quality (Bhusiri et al. 2021). The urgency of disaster response shifts procurement priorities, as time pressure outweighs the formal procedures typical of development procurement (Gutjahr and Nolz 2016; Kern 2021). Overall, humanitarian procurement strategies differ significantly based on the immediacy of the crisis and the nature of the response needed.

2.2 Sustainable Supplier Evaluation in the Humanitarian Supply Chain

Research into sustainable supplier evaluation initially focused on the environmental dimension. Pioneering scholars systematically incorporated environmental sustainability criteria into business operations (Sarkis et al. 1996) and supplier selection (Noci 1997) almost three decades ago. Subsequent reviews identify numerous overlaps in environmentally sustainable criteria with those of environmental management systems (Govindan et al. 2015; Sahabuddin et al. 2023). Conversely, socially sustainable criteria have gained relatively less attention (Bai and Sarkis 2010; Ahmadi et al. 2017; Khokhar, et al. 2020; Anjomshoae et al. 2022). The frequently proposed criteria encompass health and safety, employment practices, training and education, and impact on local communities and other stakeholders (Bai and Sarkis 2010; Govindan et al. 2015; Ahmadi et al. 2017).

Research on humanitarian procurement, especially in sustainable supplier evaluation, remains limited. Few studies have considered sustainability in some optimization models (Rodríguez-Espíndola et al. 2023). A review by Moshtari et al. (2021) identified 51 publications on humanitarian procurement, with only a few addressing supplier evaluation (Balcik and Ak 2014; Kim et al. 2019; Venkatesh et al. 2019). Despite the growing emphasis on sustainability, this dimension is overlooked (Abrahams 2014). Gralla et al. (2014) reported that the most important criterion during the first week of disaster response is the total quantity of relief items delivered, while costs are less critical. Balcik and Ak (2014) proposed key criteria for framework agreements in disaster response, including minimum purchase commitments, reserve capacity, cost, and geographical coverage, with an emphasis on lead times and delivery expenses. Kim et al. (2019) categorized 14 criteria for selecting logistics service providers into economic (cost, quality, delivery, flexibility, financial capability, and relationships), technical (facilities, capability, forecasting, innovation), and social (community projects, crisis management, grants, and stakeholder influence) categories.

Kern (2021) noted that HOs often prioritize traditional metrics such as price and quality while underemphasizing sustainability criteria in supplier evaluation methodologies. The author adopted 22 SECs (Luthra et al. 2017) and identified the four most critical criteria, namely, quality, delivery and service, costs, and production facilities and capacity, excluding occupational health and safety systems along with environmental and social measures, which were generally ranked as "slightly important" by practitioners (Kern 2021). Similarly, Bhusiri et al. (2021) highlighted that numerous HOs adopt a narrow view of suppliers, categorizing them primarily by procurement value, which leads to a focus on cost minimization rather than risk mitigation. Gutjahr and Nolz (2016) identified eight criteria for multicriteria optimization, including cost, response time, travel distance, reliability, and security. An additional review by Moshtari et al. (2021) highlighted supplier evaluation criteria such as costs, safety stock, speed, after-sale service, working conditions, labor practices, and environmental concerns.

Tay et al. (2025c) revealed that sustainable supplier assessment in HOs is still an emerging area in practice and research. While the criteria for relief and development procurements overlap, their priorities can vary significantly. Figure 1 presents the multicriteria supplier evaluation framework that addresses critical dimensions. The criteria are categorized into four dimensions: economic, resilience, social, and environmental (Tay et al. 2025c). Our research aims to evaluate the relative significance of these criteria in non-emergency and emergency humanitarian relief situations.

Economic Criteria	Resilience Criteria
Cost	Financial stability
Lead time	Geographical coverage
Quality	Security
Compliance	Safety stock
After-sale service	Flexibility
Communication	Reliability
Logistical capacity	Visibility
Commitment	Product portfolio
Relevant experiences	Reserve capacity
References	Crisis management experience
Social Criteria	**Environmental Criteria**
Labor practice	Environment management systems
Working conditions	Green packaging
Information disclosure & transparency	Green products
Influence on community	Green purchasing
Influence on other stakeholders	Waste management & pollution prevention

Fig. 1 Multicriteria supplier evaluation framework *Source* Tay et al. (2025c)

2.3 Resilient Supplier Evaluation in Humanitarian Supply Chains

Supply chain resilience, the capacity to recover from disruptions, has become critical, especially since COVID-19. Establishing a resilient humanitarian supply chain is essential for overcoming future disruptions arising from pandemics and large-scale disasters (Anjomshoae et al. 2022). Resilience strategies focus on anticipating, responding to, and recovering from disruptions while maintaining operational continuity (Sarkar et al. 2022; Odulaja et al. 2023). Suppliers often contribute to disruptions through delays, failure to meet orders, or inability to handle demand fluctuations. While resilience in humanitarian supply chains is increasingly recognized, research remains limited (Singh et al. 2018; Lamenza et al. 2019; Bhusiri et al. 2021; Hu et al. 2022).

Kovács and Falagara Sigala (2021) argued that humanitarian logistics, which are accustomed to managing crises, provide valuable insights for mainstream supply chains that traditionally focus on cost efficiency. They emphasized preparedness, innovation, and collaboration over cost minimization, offering a model for managing disruptions. This shift aligns with strategies such as prepositioning relief items and dual sourcing to enhance resilience in humanitarian contexts (Duran et al. 2011; Haavisto and Kovács 2014; Iakovou et al. 2014). Strategies such as supply diversification, agile practices, and the use of advanced technologies for improved visibility are now essential (Cooper 2024). Firms operate in interconnected networks, necessitating resilient supply chains to withstand disruptions (Ponis and Koronis 2012; Hohenstein et al. 2015). Key resilience strategies include agility, adaptability, collaboration, and maintaining safety stocks to mitigate risks (Odulaja et al. 2023; Nel 2024).

Supplier evaluation is crucial to resilience, requiring an expanded focus beyond cost and quality. Evaluating suppliers' ability to recover from disruptions, financial stability, and operating capacity is essential (Sawyerr 2021). Common themes include communication, collaboration, local sourcing, and flexibility, with resilience concerns reshaping existing evaluation criteria towards flexibility and redundancy (Bhusiri et al. 2021). These findings support the notion that resilience concerns do not necessarily introduce new criteria for supplier evaluation but may prioritize existing criteria, with more weight shifting from cost and efficiency to flexibility and redundancy.

2.4 Decision Making in Procurement

In the humanitarian sector, decision making is a critical concern because of the need to respond to disasters and their impacts on affected populations (Goldschmidt and Kumar 2019; Mediouni et al. 2019; Prasad et al. 2019). While sustainability and resilience are critical in supplier selection, their integration in humanitarian contexts remains limited despite extensive research on sustainable supplier evaluation (Fathollahi-Fard et al. 2020; Kannan et al. 2020; Liu et al. 2020). Traditionally, integrated decision-making techniques, such as weight determination and supplier evaluation methods (Hendiani et al. 2020; Shang et al. 2022; Wang et al. 2024) for resilience-based supplier selection, often overlook the importance of determining criteria weights that account for their interrelationships (Fallahpour et al. 2021). The sustainable suppliers' performance evaluation process typically encompasses two main steps: (1) identifying appropriate criteria for assessing supplier performance and (2) developing a method for calculating suppliers based on the specified attributes.

To address these complexities, a variety of structured decision-making tools have been used in procurement research.

- **Delphi Method**—Widely applied when expert consensus is needed under uncertainty. Through a series of questionnaires with controlled feedback, reliable agreement among geographically dispersed experts can be achieved, particularly in building multidimensional evaluation frameworks in humanitarian logistics (Dalkey and Helmer 1963).
- **Design Thinking**—An innovation-oriented approach emphasizing empathy with end users, problem reframing, and iterative prototyping (Wolniak 2017). In humanitarian contexts, it integrates the needs of affected populations and field staff into procurement processes, ensuring context-specific, adaptable solutions.
- **Best–Worst Method (BWM)**—A pairwise comparison-based multicriteria decision-making method that is formulated as a linear program for determining criterion weights using only the best and worst elements, requiring only 2n−3 comparisons for n criteria. This makes it more efficient and consistent than traditional pairwise comparison methods, particularly in contexts such as humanitarian procurement where rapid and reliable decision making is required under uncertainty, and suitable for various case studies (Rezaei 2016). Several studies have applied the BWM to green-resilient supplier evaluation (Fallahpour et al. 2021; Hailiang et al. 2023).

3 Methodology

This study adopts a multi-stage research approach combining expert data collection, descriptive statistical analysis, the Delphi method, the best-worst method (BWM), and design thinking. The methodology is structured to identify and prioritize supplier evaluation criteria across different humanitarian procurement contexts and subsequently develop and refine a practical supplier evaluation framework (SEF).

3.1 Data Collection

For the first step of the research, the data collected included 21 valid responses from different organizations. The panel has a broad and diverse composition of participants who specialize in humanitarian procurement and supply chain management. They are at different levels, with an average of 12 years of functional experience (ranging from 3 to 30 years) and represent different organization types operating in different regions (Table 1). This diverse mix gives us a balanced perspective.

Table 1 The type of humanitarian organizations (HOs) represented by the participants

Organizational type	Sub-total
International NGO	10
Local NGO	2
UN agency	4
Consultancy	4
Government agency	1
Total	21

3.2 Data Analysis

The project employs the Delphi method and design thinking approach as the research methods (Fig. 1). The Delphi method is suitable for exploring research topics where no consensus has been established, and was selected for evaluating the topic of challenges in incorporating resiliency and sustainability criteria. First, the Delphi method was used to identify and finalize the evaluation criteria with experts. Then, the BWM was applied to determine the precise weights of these criteria. The BWM was selected for its efficiency in data collection from time-constrained humanitarian professionals and its ability to provide more consistent and reliable results compared to other pairwise comparison methods (Erden et al. 2024). On the basis of the multicriteria evaluation framework identified in the literature (Fig. 1) by Tay et al. (2025c), it applies the descriptive statistical analysis method to identify the "as-is" (that is, currently applied) and "should-be" supplier evaluation criteria (SECs) in practice as Delphi round one, the BWM to determine the context-specific SEC weights in Step 2 as Delphi round two, and design thinking at Step 3 to develop, test, and refine the supplier evaluation framework (SEF) for HOs. The study considers humanitarian procurement in four contexts: non-emergency procurement (NEP) of goods and services (for missions such as steady-state development programs, pre-disaster prepositioning, and post-disaster rebuilding) and emergency procurement (EP) of goods and services (for missions such as disaster relief with high levels of urgency).

The study adopts the BWM to identify the context-contingent weights of supplier evaluation criteria by surveying a panel of humanitarian practitioners. Based on the results, a holistic SEF is proposed by synthesizing the learning from the literature and the findings from analyzing the primary data collected in Steps 1 and 2. The optimal SEC weights were then used to develop an SEF, which was refined and validated through expert feedback Fig. 2.

3.2.1 Identifying As-Is versus Should-Be SECs via Descriptive Statistical Analysis

Step 1 adopts descriptive statistical analysis to ascertain the As-Is and Should-Be SECs for both the NEP and the

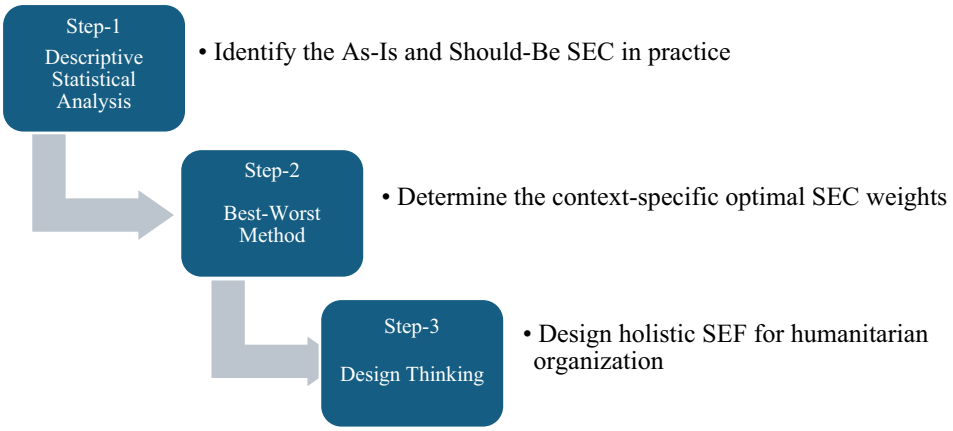

Fig. 2 Research method and approach. SEC = Supplier evaluation criteria; SEF = Supplier evaluation framework

EP of goods and services. The interviews were recorded (with the participants' written consent), transcribed, and analyzed. Descriptive statistical analysis was applied to summarize the answers to the closed questions and formulate group responses. The analysis produced As-Is and Should-Be SECs for NEP and EP (Fig. 3) with anonymized group responses. The As-Is SECs illustrate the actual practices in the participants' organization, and the Should-Be SECs reflect the participants' opinions on the desirable practices. The 70%/30% inclusion/exclusion threshold was chosen to balance comprehensiveness and parsimony to eliminate unnecessary redundancy and improve adoption feasibility.

Fig. 3 As-Is and Should-Be supplier evaluation criteria (SECs) for non-emergency procurement (NEP) and emergency procurement (EP)

SEC	As-Is (NEP)	Should-Be (NEP)	As-Is (EP)	Should-Be (EP)
Economic				
Cost	100%	0%	76%	0%
Lead time	100%	0%	100%	0%
Quality	100%	0%	100%	0%
Compliance	100%	0%	88%	0%
After-sale service	89%	100%	53%	0%
Communication	84%	100%	47%	0%
Resilience				
Financial stability	84%	100%	59%	0%
Geographical coverage	79%	75%	47%	0%
Security	79%	75%	47%	0%
Safety stock	68%	83%	47%	0%
Flexibility	58%	100%	53%	0%
Reliability	58%	75%	47%	0%
Visibility	47%	100%	41%	0%
Social				
Labor practice	95%	100%	59%	0%
Working conditions	79%	100%	53%	0%
Information disclosure and transparency	58%	88%	35%	0%
Influence on community	53%	89%	41%	0%
Environmental				
Environment management systems	53%	89%	18%	0%
Green packaging	32%	92%	12%	0%
Green products	26%	86%	6%	0%

3.2.2 Determining the Context-Specific SEC Weights

Step 2 seeks to determine the context-specific SEC weights by surveying the same panel. The application of the BWM involves five steps (Rezaei 2015, 2016). They are (1) determining a set of decision criteria; (2) determining the best and worst criteria; (3) determining the preference of the best criterion over all the other criteria using a number between 1 and 9; (4) determining the preference of all the criteria over the worst criterion using a number between 1 and 9; and (5) finding the optimal weights. First, a set of evaluation criteria (conducted in Step 1) is identified. Second, the "best" (B, the most important) and the "worst" (W, the least important) criteria are identified. In the next step, assess the relative importance of the "best" criterion by comparing it with each of the other criteria using a number between 9 and 1; the resulting best-to-others vector would be AB = (aB1, aB2, …, aBn), where aBj indicates the best criterion B over criterion j. Later, determine the relative importance of each of the other criteria over the "worst" criterion using a number between 9 and 1; this would result in an others-to-worst vector AW = (a1W, a2W, …, anW). Finally, find the optimal weights of the criteria (w1*, w2*, …, wn*).

The questionnaire includes four sections that assess the SECs' weights for

(1) Should-Be NEP criteria of goods;
(2) Should-Be NEP criteria of services;
(3) Should-Be EP criteria of goods; and
(4) Should-Be EP criteria of services.

To identify desirable "should-be" criteria for enhancing resilience and sustainability in humanitarian procurement, respondents completed a structured BWM survey across four sections. They first selected the most ("best") and least ("worst") important criteria from the SEC lists. Then, they rated the relative importance of the best criterion against each other criterion on a 9-to-1 scale (9 = "extremely more important," 1 = "similarly important") and similarly compared each criterion with the worst criterion. A zero option allowed participants to indicate irrelevance. Text boxes were provided for comments, enabling the experts to review and revise their prior Delphi round one response. An additional question assessed whether the responses were based on personal experience, observation, or perception to gauge confidence and filter out nonexperiential answers. Finally, the participants were asked if they would be willing to review and provide feedback on the proposed SEF in subsequent stages.

$$
\begin{aligned}
& min \xi^L \\
s.t. \quad & w_B - a_{Bj} w_j \le \xi^L, \forall j \\
& -(w_B - a_{Bj} w_j) \le \xi^L, \forall j \\
& w_j - a_{jW} w_W \le \xi^L, \forall j \\
& -(w_j - a_{jW} w_W) \le \xi^L, \forall j \\
& \textstyle\sum_{j=1}^{n} w_j = 1 \\
& w_j \ge 0, j = 1, \ldots, n
\end{aligned}
$$

where w_B and w_W denote the weights of the best and worst criteria, respectively, a_{Bj} and a_{jW} are the best-to-others and others-to-worst preference values, and ξ^L represents the consistency measure (Rezaei 2016).

These thresholds are not the basic consistency index (CI) values from Rezaei (2015), but the more refined consistency ratio (CR) acceptability thresholds that account for both the number of criteria and the maximum preference value on the comparison scale. These thresholds were derived by solving the BWM model under worst-case inconsistent scenarios.

3.2.3 Developing a Multicriteria SEF

The SEF is then developed by synthesizing the findings from literature and the primary data collected in this study. The international participants who indicated their interest in participating in the Step 3 study were then contacted via email for a virtual focus group Zoom discussion to review the SEF in terms of its applicability in practice, its ease of use, and the areas that need improvements. The comments from the participants are then analyzed and synthesized to refine the proposed SEF, as presented in Sect. 5.

4 Findings

This section presents the findings following the three-step analytical process described in Sect. 3.2.

4.1 Descriptive Analysis: As-Is and Should-Be Supplier Evaluation Criteria

Delphi round one analysis revealed that social sustainability criteria are incorporated into supplier evaluations, whereas environmental criteria are poorly implemented. Figure 3 highlights the current (As-Is) and desirable (Should-Be) SECs that achieved over 70% group consensus for the non-emergency procurement (NEP) and emergency procurement (EP). In the NEP, 11 criteria are currently applied. Among the economic criteria, cost, lead time, quality, and compliance achieved 100% consensus, whereas after-sale services and communication exceeded 80%. Among the resilience criteria, financial stability, geographical coverage, and security surpassed 70%, while within the social criteria, labor

practices and working conditions exceeded 70%. No environmental criteria reached the 70% threshold.

In addition to the currently applied As-Is criteria in the NEP, nine desirable SECs for resilience, social, and environmental criteria were identified, but are not yet used in practice. No new Should-Be criteria were proposed for the economic criteria, whereas safety stock (83%), flexibility (100%), reliability (75%), and visibility (100%) were proposed. Two social criteria—information disclosure and transparency, and community influence—received nearly 90% of the group consensus. Three additional criteria that exceeded 70% were proposed for the environmental criteria: environmental management systems, green packaging, and green products.

According to the humanitarian procurement experts, the current economic criteria are sufficient. However, a more comprehensive approach is needed to increase resilience and sustainability by incorporating additional resilience, social, and environmental criteria. The experts also indicated two SECs not identified in our literature review, namely, past relevant experience (indicated by seven experts) and references from other customers (indicated by four experts). The experts noted that prequalification of potential suppliers often includes background checks, business and tax registration certificates, compliance with labor and anticorruption standards, absence of legal cases or blacklisting, and donor-specific requirements such as restrictions on sourcing certain items from specific origins.

For EP, four economic SECs (cost, lead time, quality, and compliance) are currently used, with more than 70% consensus among the HOs. Fewer criteria are applied in EP than in NEP because of the nature of emergency responses. While too many suppliers and criteria can increase costs, too few suppliers may expose the HOs to supply risks, making it essential to strike a balance for efficient and reliable emergency management (Hou et al. 2024). Among these SECs, lead time and quality are prioritized over compliance and cost, and noneconomic criteria are rarely considered in EP.

No additional SECs were identified for emergency procurement. This finding underscores the practical constraints on supplier evaluation during emergencies, particularly because of time constraints.

4.2 Best-Worst Method Analysis: Context-Specific Supplier Evaluation Criteria Weights

Following the identification of the As-Is and Should-Be SECs in Step 1, the BWM was applied in Delphi round two to obtain the optimal weight of each criterion when evaluating suppliers for NEP and EP. A four-section Qualtrics questionnaire sought the participants' expertise and insights into the criteria and their organization's existing practices. Among the seven participants, six responses were usable for the BWM after data filtration. While the sample size is small, the analysis is not intended to generate generalizable results and instead, it draws on the judgement of domain experts. Small expert panels have been used in other studies where the emphasis is on domain expertise (for example, Lo and Liou 2018; Rosário et al. 2021; Garcia et al. 2026).

To capture the different dimensions of supplier evaluation, the criteria were grouped into four subsets: economic, resilience, social, and environmental, as in Step 1. As the analysis involved more than nine criteria, this clustering also facilitated the pairwise comparisons required by the BWM. If the input consistency ratio did not exceed the threshold, the consistency of the comparisons was considered acceptable, allowing optimal weights of the criteria to be derived. This process was repeated across four questionnaire sets to determine the optimal SEC weights. A sample BWM calculation for goods procurement in the NEP is provided in the Appendices,[1] while Tables 2 and 3 present the optimal weights for goods and service procurement across different scenarios.

For NEP supplier evaluation (Table 2), the Should-Be social criteria—working conditions (0.261 in Goods, 0.293 in Services) and labor practice (0.191 in Goods, 0.236 in Services)—are heavily weighted, reflecting the increasing importance of ethical labor practices. Moreover, influence on the community and information disclosure and transparency are included to support public engagement. Among the resilience criteria, reliability received the highest weight, with flexibility, visibility, and geographical coverage ensuring adaptability and reach. Product's performance, pricing, and delivery time are also important economic considerations. Factors such as references from other customers and compliance are also crucial for ensuring supplier credibility and adherence to standards. Environmental criteria such as environmental management systems, green products, and green packaging are also recommended, indicating the relevance of environmentally responsible supplier practices.

During emergencies, urgency and adaptability are paramount, making suppliers who provide fast, reliable, and effective solutions essential. For both goods and service procurement in EP, resilience criteria carry the highest weight, with flexibility identified as the most significant factor, enabling suppliers to swiftly adjust to urgent demands and supply chain disruptions. Financial stability also ranks highly, as stable suppliers are more likely to meet commitments during crises. Economic criteria emphasize cost-effectiveness, quality, and delivery speed, with quality and lead time prioritized to ensure that standards are met and required delivery timelines are achieved. While cost and compliance remain important, they are secondary to speed and reliability.

[1] https://zenodo.org/records/21989101

Table 2 Should-Be supplier evaluation criteria (SECs) for non-emergency goods/service procurement (NEP)

Goods procurement in NEP		Service procurement in NEP	
Economic criteria	Weight	Economic criteria	Weight
Quality	**0.163**	Quality	**0.185**
Cost	0.161	Cost	0.142
Lead time	0.155	Lead time	0.139
Reference from other customers	0.132	Compliance	0.139
Compliance	0.127	Reference from other customers	0.131
Relevant past experiences	0.107	Relevant past experiences	0.116
Communication	0.096	Communication	0.091
After-sale services	0.061	After-sale services	0.059
Resilience criteria		Resilience criteria	
Reliability	**0.292**	Reliability	**0.21**
Flexibility	0.175	Flexibility	**0.191**
Geographical coverage	0.136	Visibility	0.175
Visibility	0.111	Geographical coverage	0.129
Safety stock	0.106	Safety stock	0.127
Financial stability	0.103	Financial stability	0.101
Security	0.078	Security	0.076
Social criteria		Social criteria	
Working conditions	**0.261**	Working conditions	**0.293**
Labor practice	**0.191**	Labor practice	**0.236**
Influence on community	0.121	Influence on community	0.116
Information disclosure and transparency	0.086	Information disclosure and transparency	0.071
Environmental criteria		Environmental criteria	
Environmental management systems	0.154	Green packaging	0.103
Green packaging	0.095	Green products	0.103
Green products	0.092	Environmental management systems	0.078

Bold values indicate the criteria identifi ed as most heavily weighted/critical within each criteria category (Economic, Resilience, Social, Environmental), based on the BWM results and expert discussion. This may include more than one criterion where weights are closely clustered or the discussion highlights multiple critical factors

Ethical labor practices and working conditions continue to be relevant, whereas environmental considerations are generally omitted under emergency conditions because of the urgency and time constraints involved.

In summary, the key findings are:

- The integration of environmental criteria in supplier evaluation is still in its emerging stages.
- Increasing stakeholder engagement and securing donor support are critical for achieving resilience and sustainability in humanitarian procurement.
- Ethical labor practices and working conditions continue to be critical amid of emergency or non-emergency.

4.3 Development of the Supplier Evaluation Framework

Building on the BWM results in Step 2, Step 3 consolidates the SECs and their weights into a holistic supplier evaluation framework (SEF). The weights for goods and service procurement were averaged to derive consensus values for the NEP and EP, reflecting the most important SECs under each condition. These average weights were then used to rank the critical SECs, as shown in Table 4, providing HOs with reference points for applying criteria in their specific operational contexts. The BWM weights serve as reference points for ranking criteria in real-world scenarios.

The analysis revealed notable differences between procurement types. For the NEP, social and resilience criteria, such as working conditions, labor practices, and reliability, were prioritized, highlighting a long-term sustainability focus. In contrast, flexibility, lead time, and quality were the dominant factors in EP, where speed and reliability were critical.

The final framework includes 22 SECs for the NEP and 10 SECs for the EP, providing HOs with a practical tool to support sustainable and resilient supply chains. Humanitarian organizations can apply all of the proposed criteria or select those most relevant to their operational context, adjust rankings and weights as needed, and use the BWM to

Table 3 Should-Be supplier evaluation criteria (SECs) for emergency goods/service procurement (EP)

Goods procurement in EP		Service procurement in EP	
Economic criteria	Weight	Economic criteria	Weight
Quality	**0.255**	Quality	**0.246**
Lead time	**0.231**	Lead time	**0.221**
Logistical capacity	0.165	Cost	0.185
Compliance	0.153	Compliance	0.182
Cost	0.151	Logistical capacity	0.141
After-sale service	0.048	After-sale services	0.025
Resilience criteria		Resilience criteria	
Flexibility	**0.487**	Flexibility	**0.408**
Financial stability	**0.212**	Financial stability	**0.196**
Social criteria		Social criteria	
Labor practice	**0.188**	Labor practice	**0.242**
Working conditions	0.114	Working conditions	0.155
Environmental criteria		Environmental criteria	
NA		NA	

Bold values indicate the criteria identifi ed as most heavily weighted/critical within each criteria category (Economic, Resilience, Social, Environmental), based on the BWM results and expert discussion. This may include more than one criterion where weights are closely clustered or the discussion highlights multiple critical factors

evaluate and rank suppliers against each criterion. Notably, environmental criteria are excluded from the EP framework because the expert findings indicate that immediate operational priorities take precedence under emergency conditions. Together, these findings provide the basis for the proposed holistic SEF and address Research Question 1.

Humanitarian organizations can adopt the proposed SEF framework (Fig. 4) to evaluate and select suppliers to mitigate disruption risk and improve economic and environmental efficiency in both non-emergency and emergency phases. The framework comprises five steps, culminating in the aggregation of weighted scores to obtain a total score for each supplier. It offers a practical, adaptable tool for assessing suppliers' economic, environmental, social, and resilience-related factors. This flexibility allows the incorporation of evolving criteria in response to the changing demands of supply chain management in humanitarian contexts.

4.4 Application of the Proposed Framework

A demonstration of a multicriteria supplier evaluation scoring matrix for EP is presented in Table 5. In this demonstration, three suppliers are evaluated based on their performance (P) for criteria in EP. To obtain a weighted score, BWM weights are applied to the performance of

Table 4 Critical weighted desirable (Should-Be) supplier evaluation criteria (SECs) for non-emergency procurement (NEP) and emergency procurement (EP)

NEP	Criteria	Weight	EP	Criteria	Weight
Working conditions	Social	0.092	Flexibility	Resilience	0.224
Reliability	Resilience	0.082	Quality	Economic	0.125
Labor practice	Social	0.071	Lead time	Economic	0.113
Flexibility	Resilience	0.061	Labor practice	Social	0.108
Quality	Economic	0.058	Financial stability	Resilience	0.102
Cost	Economic	0.050	Cost	Economic	0.084
Lead time	Economic	0.049	Compliance	Economic	0.083
Visibility	Resilience	0.048	Logistical capacity	Economic	0.077
Geographical coverage	Resilience	0.044	Working conditions	Social	0.067
Reference from other customers	Economic	0.044	After-sale services	Economic	0.018
Compliance	Economic	0.44	Total		1
Influence on community	Social	0.040			
Safety stock	Resilience	0.039			
Environmental management systems	Environmental	0.039			
Relevant past experiences	Economic	0.037			
Financial stability	Resilience	0.034			
Green packaging	Environmental	0.033			
Green products	Environmental	0.033			
Communication	Economic	0,031			
Information disclosure and transparency	Social	0.026			
Security	Resilience	0.026			
After-sale services	Economic	0.020			
Total		1			

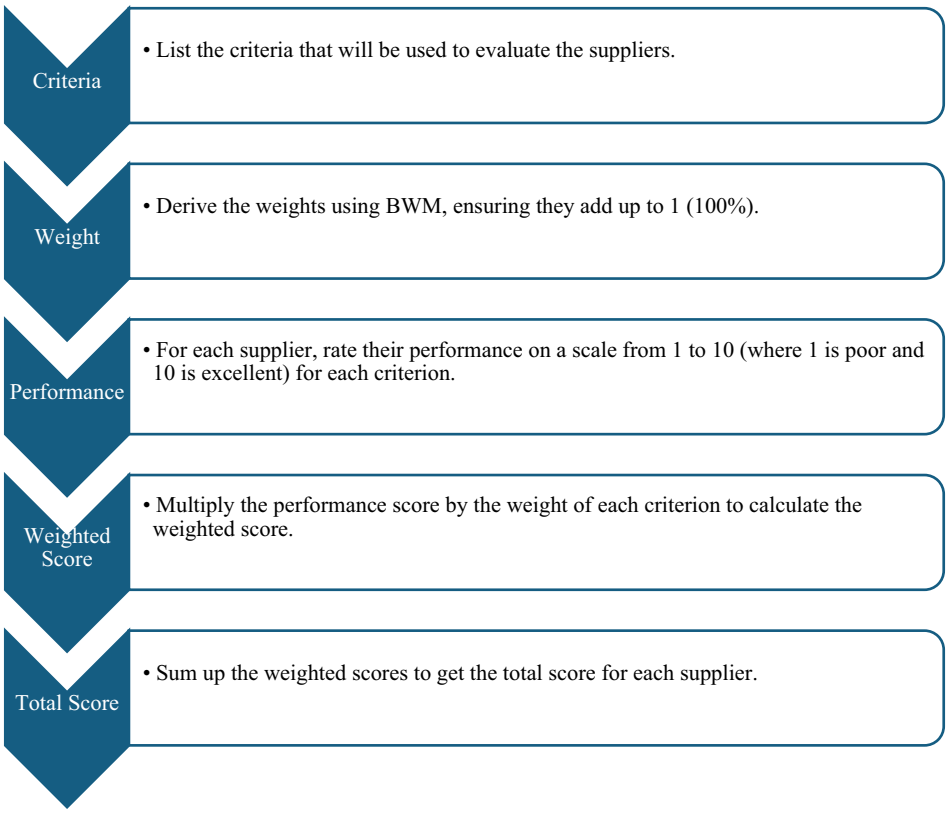

Fig. 4 Supplier evaluation framework (SEF) for emergency procurement (EP) and non-emergency procurement (NEP). BWM = Best-worst method

Table 5 Demonstration of supplier evaluation for emergency procurement (EP) by the supplier evaluation framework (SEF)

		Supplier 1		Supplier 2		Supplier 3	
Criteria	Best-worst method (BWM) weight	P (1 to 10)	Weighted score	P (1 to 10)	Weighted score	P (1 to 10)	Weighted score
Flexibility	0.224	8	1.792	10	2.24	8	1.792
Quality	0.125	7	0.875	10	1.25	6	0.75
Lead time	0.113	9	1.017	8	0.904	8	0.904
labor practice	0.108	6	0.648	10	1.08	7	0.756
Financial stability	0.102	10	1.02	5	0.51	10	1.02
Cost	0.084	7	0.588	4	0.336	8	0.672
Compliance	0.083	3	0.249	5	0.415	6	0.498
Logistical capacity	0.077	5	0.385	3	0.231	7	0.539
Working conditions	0.067	4	0.268	6	0.402	2	0.134
After-sale services	0.018	2	0.036	1	0.018	1	0.018
Total weighted score	1.00		6.878		**7.386**		7.083

The bold value indicates the supplier with the highest total weighted score, that is, the top-ranked supplier under the proposed SEF

multiple suppliers. The total weighted score reflects the supplier's overall performance. This matrix allows us to compare suppliers based on how well they meet the critical criteria and rank them accordingly. In this case study, Supplier 2 is the best when evaluating emergency procurement. Depending on contextual needs, HOs can modify the criteria, weights, and supplier scores accordingly.

A focus group discussion was conducted via Zoom with regional experts in humanitarian procurement and the supply chain to evaluate the applicability of the proposed SEF. The framework was demonstrated to explore feasibility and gather feedback. The experts recommended categorizing the criteria into three levels: mandatory, minimum, and optional for different scenarios. They highlighted that,

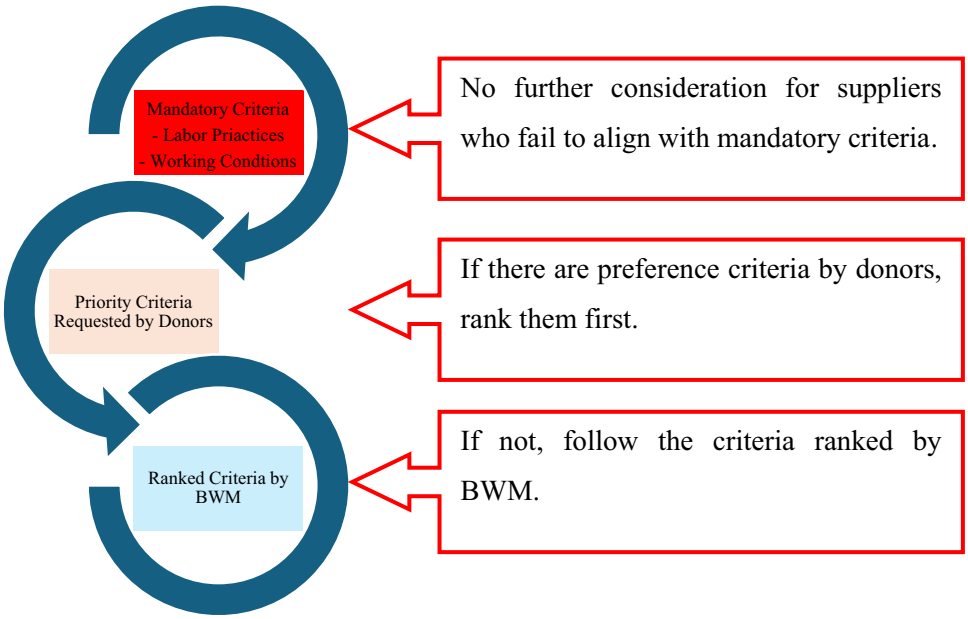

Fig. 5 Systematic approach for ranking supplier evaluation criteria (SECs). BMW = Best-worst method

beyond achieving a high weighted score, practical factors such as logistical capacity may take precedence, even if they require selecting a slightly more expensive supplier. While economic and resilience criteria are often emphasized, the importance of integrating environmental and social factors in EP remains important but is still emerging.

Donors' preferences significantly influence procurement decisions and alignment with donor priorities, ensuring that HOs secure funding, maintaining transparency, and strengthening resilience (Heaslip et al. 2019; Anjomshoae et al. 2022). For example, one donor prioritized green packaging and waste management, whereas labor practices and working conditions were deemed nonnegotiable, disqualifying suppliers who failed to comply. The key principles of ethical procurement are fairness, transparency, integrity, and respect for human rights to prevent worker exploration, unsafe working conditions, environmental degradation, and community economic instability. Integrating these principles into procurement reinforces fair labor practices, builds stakeholders' trust, and fosters a more sustainable and socially responsible supply chain process (Victor Ibukun et al. 2024). All supply chain professionals must ensure compliance with legal and ethical standards across international contexts (Gordon 2023).

5 Discussion

This section evaluates feedback from practitioners and incorporates their perspectives in discussing the implications for supporting transparent, sustainable, as well as context-sensitive supplier selection in both emergency and non-emergency settings. The BWM simplifies and improves the efficiency of supplier evaluation by requiring fewer decision-maker interactions and inputs, making it particularly advantageous for HOs facing time constraints, fatigue, or low engagement. In this study, the BWM is extended to incorporate decision making under uncertain and gray environments, advancing previous formulations for determining relative attribute weights (Bai et al. 2019). Although environmental criteria are often deprioritized during emergency procurement due to time sensitivity, a set of minimum environmental standards can still be maintained. These may include compliance with basic environmental regulations, avoidance of hazardous materials, and minimal packaging requirements. To bridge this gap, the framework could be applied by mandating such environmental criteria during the pre-qualification stage, when suppliers are vetted before a crisis occurs, rather than during the immediate response phase. This then allows HOs to draw from a pool of pre-approved suppliers, who would already have met the minimum environmental thresholds, during emergency operations. Practitioners emphasized the importance of ethical procurement and agreed that the SEF is both feasible and scientifically grounded. They noted that the framework could standardize processes across HOs, enhancing transparency and objectivity, and expressed interest in implementing it within their organizations and field offices. Moreover, raising awareness among donors and communities is critical to incorporating relevant SECs and achieving resilient, sustainable procurement. Multiple stakeholders, such as donors, field staff, and affected communities, strengthen decision making, ensure inclusivity, and align procurement outcomes more closely with the needs and values of those impacted.

The purpose of Fig. 5 is to guide HOs in evaluating criteria weights for relevant goals. The mandatory criteria are binary: "yes" for further consideration or "no" for excluding a supplier. Once mandatory criteria are met, donor-specific requirements are prioritized. These two types of criteria do not require further evaluation, as they are essential. The remaining criteria, listed in Step 1 of the SEF, are assessed via the BWM to determine weights and rank suppliers scientifically. Continuous training and feedback ensure stakeholder engagement, whereas close collaboration with donors enhances relevance and may help secure additional funding.

The overall aim of this study is to provide a systematic approach for supplier evaluation that considers context-specific supplier evaluation criterion priorities across four dimensions—economic, resilience, social, and environmental—in both non-emergency and emergency humanitarian relief situations. Taken together, Figs. 4 and 5 illustrate the complete proposed supplier evaluation framework and its application, demonstrating how criterion priorities shift across the four sustainability dimensions between non-emergency and emergency phases.

6 Conclusion

Our research focused on formulating a multicriteria supplier evaluation framework (SEF) that considers the suggested improvements on the list of SECs while also considering additional suggestions about suppliers, processes, and contextual factors. The increasing demand for humanitarian aid due to conflicts, climate emergencies, and economic instability underscores the importance of effective, resilient, and sustainable supply chains. This research utilized the BWM to address Research Question 1, identified the critical SECs, and proposed an SEF for the NEP and EP. The framework is designed to be practical and adaptable, allowing HOs to apply the weights derived to evaluate and rank suppliers based on their performance against critical criteria. By applying the proposed SEF, HOs can systematically assess suppliers while addressing key sector-specific challenges such as urgency, supply uncertainty, and donor accountability. The methodology contributes to humanitarian procurement by integrating operational, ethical, and contextual criteria into a structured decision-making process. This enables humanitarian organizations to enhance transparency, improve accountability, and strengthen supply chain resilience while remaining responsive to rapidly evolving logistics and emergency conditions.

The proposed framework is a structured and systematic decision-making approach that leverages the BWM and weighted prioritization to increase operational effectiveness. It allows easy adjustments to SECs based on procurement circumstances, improving efficiency and reducing risks. This adaptability ensures the framework's relevance across diverse contexts while providing scientifically grounded weighting criteria. By applying this structured evaluation, HOs can strengthen procurement performance, thereby contributing to resilience and sustainability in their supply chains and addressing Research Question 2.

The identified supplier evaluation criteria align with prior studies, particularly in terms of cost efficiency, lead time, and quality. However, this study extends the literature by emphasizing context-specific factors such as flexibility, reliability, and ethical compliance, which are critical in humanitarian settings. The prominence of resilience and adaptability highlights the need to recalibrate traditional criteria for dynamic and resource-constrained environments.

Policymakers and major donors could first pilot the SEF in a specific region or for specific commodity types, providing training and support to HOs. Before considering wider mandates, HOs can consider several on-ground activities such as co-structured stakeholder workshops, integrating beneficiary feedback mechanisms, or co-designing criteria with local suppliers to gather feedback from suppliers on the feasibility and perceived fairness of the evaluation criteria.

The framework's effectiveness depends on the availability and accuracy of supplier data, which may be challenging in certain humanitarian contexts. Despite this limitation, the SEF enables organizations to meet immediate beneficiary needs while building long-term, sustainable, and resilient supply chains. The findings highlight the importance of integrating economic, social, environmental, and resilience dimensions to achieve ethical and efficient humanitarian operations. Considering these implications and limitations, future refinements and applications of the SEF can further enhance its value across humanitarian and procurement contexts.

7 Limitations and Future Research

This SEF approach also presents certain limitations, as it does not account for nuanced contextual factors such as organizational type and geographic location and excludes suppliers' perspectives, which could offer valuable insights and enhance the findings. Another limitation is that only six usable expert responses were obtained for the BWM weighting phase. While small expert panels have been used and validated in BWM-based studies, this limits the statistical generalizability of the empirical results. Hence, future research could strengthen the findings by involving a larger panel of experts. We acknowledge these constraints when interpreting the findings. Future research should address these gaps by gathering feedback from suppliers on the feasibility and perceived fairness of the evaluation criteria, and we plan to pilot the BWM-based SEF with interested HOs to

evaluate its practicality and adaptability in real-world scenarios, generating further refinement. We will test the SEF's adaptability by applying it across different types of HOs (for example, UN agencies versus local NGOs) and in diverse geographic contexts (for example, rapid-onset versus protracted crises) to develop contextualized variants This will involve comparing procurement outcomes (for example, lead time, cost-effectiveness, post-distribution feedback) between suppliers selected using the traditional method and those selected using the proposed SEF.

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