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Procurement Decisions on the Transportation of Food Aid in Humanitarian Operations

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Abstract

Purpose - The purpose of this research is to see how purchasing decisions affect food aid transit in humanitarian operations. In this context, the four criteria of transportation time, transportation costs, transportation capacity, and food loss and waste are assessed in relation to local and global procurement procedures, as well as the usage of pre-positioned stock. As a result, this research establishes the correlations between the criteria and gives implications for improvement.
Design/Methodology/Approach - Within the mono-method quantitative study, a single data collection method is used. We gathered data from respondents working in food aid using a survey, namely an online questionnaire. The data is then examined using the fuzzy analytical hierarchy process (fuzzy AHP), which is a multi-criteria decision-making technique.
Findings - Based on the four factors analyzed, the fuzzy AHP findings show that the preferred procurement approach, considering the four criteria studied, is local procurement, followed by the use of pre-positioned stock, and global procurement takes last place. According to the results of the cross-comparisons, humanitarian supply chain departments that focus on development aid allocate a relatively comparable percentage of pre-positioned stock and local procurement. However, in disaster relief, local procurement is by far the most favored sourcing method.
Research Implications - The result of the analysis shows that due to the time-sensitive nature of disaster relief, where the number of people rescued determines the response time, finding a way to increase the efficiency of humanitarian supply chain through local procurement to prevent food loss and waste and reduce transportation time is necessary. These results provide suggestions and implications for humanitarian organizations and academics. Regarding industrial implications, both development assistance and disaster relief managers and non-governmental organizations can benefit from this paper

Keywords: Development Assistance, Disaster Relief, Food Aids, Food Assistance, Humanitarian Procurement
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Ⅰ. Introduction

Humanitarian logistics is the procedure of scheduling, employing, and supervising the effective and profitable flow of stock of properties and supplies, along with related information, from the point of origin to the point of consumption to appease the affliction of endangered publics (Thomas and Mizushima, 2005). Humanitarian logistics is important enough to account for 80% of disaster relief activities. However, in aid organizations, logistics only plays a back-office role and does not take a leading role in the decision-making process (Van Wassenhove, 2006). In fact, at the time of the Indian Ocean tsunami, 42% of aid organizations excluded logistics experts when dispatching investigation teams, and only 26% of aid organizations managed relief supplies using Egels and manuals (Thomas and Kopczak, 2005). Consequently, the relief supplies sent by each group were not delivered timely to those in need; they were left at Banda Aceh Airport in Indonesia, only exacerbating the chaos of relief efforts. When unpredictable natural disasters occur, such as the Haiti earthquake, East Japan earthquake, tsunami, and flooding in Thailand, the opinions of logistics experts must be reflected in the humanitarian relief plan stage for a cost-effective and agile response. However, it will be difficult for relief organizations to secure expertise in the logistics sector without having a poor financial structure and professional labor. Meanwhile, global hunger surged in 2020 because of the COVID-19 pandemic. After being essentially stable for five years, the prevalence of malnutrition climbed from 8.4% to roughly 9.9% in only one year, constraining the Zero Hunger objective by 2030 (Food and Agriculture Organization [FAO], 2021). Although the global prevalence of moderate or severe food insecurity (as evaluated by the Food Insecurity Experience Scale) has been gradually increasing since 2014, the projected increase in 2020 was equivalent to the preceding five years combined. In 2020, about one-third of the world's population (2.37 billion) lacked appropriate food, a rise of nearly 320 million people in only one year (FAO, 2021).

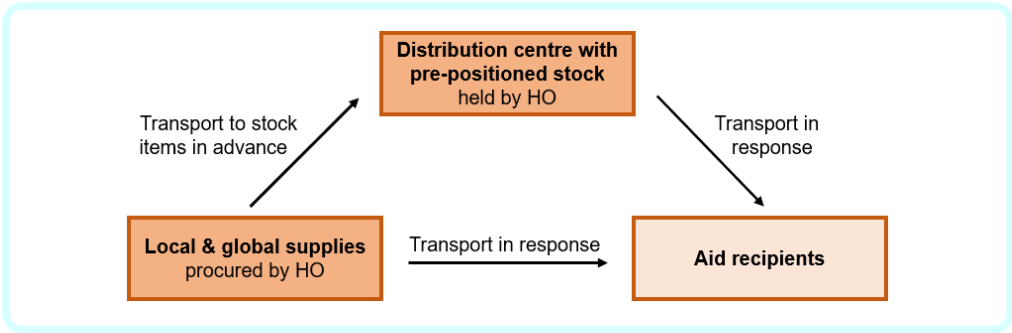
This study aims to explore how procurement affects the conveyance of food support in humanitarian situations. Improvements in the transportation of food assistance are also mentioned because of obtaining a specific conclusion. Moreover, this study explores how the selected purchase technique impacts food support shipping in humanitarian logistics. It examines the following procurement methods: local procurement (LP), global procurement (GP), and the usage of pre-positioned stock (PPS). Several research objectives are defined to address the study topic. First, this study determines which elements influence food transportation as a result of a purchase choice. The sourcing techniques will be graded on this basis.

The findings of this study may assist humanitarian organizations (HOs) in better understanding the dynamics of buying decisions and their impact on food aid transportation. This research process follows a set format. Section 2 presents the literature review. Section 3 describes the fuzzy analytical hierarchy process (AHP) technique. Section 4 provides the findings, beginning with a summary of the questionnaire responses and the fuzzy AHP examination's overall findings. Finally, Section 5 concludes the paper and presents the future ramifications and research directions.

Ⅱ. Literature Review

Several studies have addressed the humanitarian supply chain (HSC) regarding procurement and transport. For instance, Ozpolat et al. (2015) examined the procurement approaches of food aids from the United States and the European Union in their cost-efficiency. They focused on the recipient country and the donor country's approach. A similar study was conducted by Harou et al. (2013), who compared LP and GP with transoceanic supplies in Guatemala and Burkina Faso. Moreover, Falasca and Zobel (2011) addressed procurement in disaster relief. Meanwhile, Lentz et al. (2013) discussed the impacts and reasons for local sourcing in the context of humanitarian food assistance,

Fig. 1. Humanitarian Supply Chain: Procurement and Distribution



Source: Balcik and Beamon (2008).

whereas Lentz et al. (2013) detailed its cost and time effectiveness. Additionally, the obstacles and possibilities of procuring food aids in times of the COVID-19 pandemic were discussed by Cardwell and Ghazalian (2020). Further perspectives on procurement can be retrieved from studies that are based on a commercial supply chain. Hu Zhuo et al. (2015) dealt with the optimization decision problem of supplier selection in green procurement under the low carbon economy. Praneetpholkrang et al. (2021) optimized the allocation of shelters in humanitarian relief regarding criteria, such as transportation costs. Furthermore, Azmat and Kummer (2020) proposed using automotive ground vehicles and aerial machines as drones in humanitarian transport to enhance the performance of HSCs.

Figure 1 outlines the procurement in HOs, which mainly consists of global and local sourcing and the use of PPS (Balcik et al., 2010; Balcik and Beamon, 2008). It accounts for 65% of the total costs in HOs and significantly influences HSC performance (Falasca and Zobel, 2011). Nonetheless, HOs still face trade-offs independent of their procurement approach. Therefore, institutions are advised to determine their key goals to find the most suitable approach to sourcing food aids (Barrett, 2010; Lentz et al., 2013).

1. Procurement in the Humanitarian Supply Chain

GP refers to sourcing outside the nation of the recipient. Sourcing relief items globally can take more time than procuring goods locally, because of long purchasing efforts (Balcik et al., 2010; Balcik and Beamon, 2008). HOs buy global goods by bidding with suppliers after a disaster has occurred. Afterward, the supply distribution begins (Balcik and Beamon, 2008). However, constraints, such as finding free transportation capacities to ship large volumes to the destination and the custom clearance for imports, significantly affect the length of time (Balcik et al., 2010; Balcik and Beamon, 2008). Nonetheless, HOs can cover their total demand by way of GP due to the high availability of goods on the global market. Moreover, many products that are available globally meet the quality standards of the HO (Balcik and Beamon, 2008). With regard to purchasing prices of relief items, particularly processed food items tend to be cheaper on the global market (Lentz et al., 2013). Considering the current pandemic COVID-19, some studies have shown that the rising transaction and shipping costs and time delays have significantly affected the global sourcing of food aids. This has been due to import and export restrictions and coronavirus border controls. Another cause is the movement regulations within the countries (Cardwell and Ghazalian, 2020).

LP describes the sourcing of relief items at or close to the recipient's location. One significant factor of sourcing locally or regionally is time. Many studies determined that aids arrive faster if

they are purchased close to the recipient (Balcik et al., 2010; Balcik and Beamon, 2008; Harou et al., 2013; Lentz et al., 2013). Time savings can be seen particularly in countries, which lack access to the sea (Harou et al., 2013; Lentz et al., 2013). Additionally, time is saved by the omission of the customs clearance (Balcik and Beamon, 2008). Another important factor of humanitarian procurement is the availability of the aids in the desired quantity. This can be limited mainly if several HOs procure similar goods locally (Balcik and Beamon, 2008). Apart from that, finding national suppliers that cover the full demand can be a challenge, as seen in Burkina Faso and Guatemala (Harou et al., 2013). This also applies to meeting the quality and safety requirements (Balcik and Beamon, 2008). However, it again depends on the country (Harou et al., 2013). Regarding the nutritious value of local food, local food was more nutritious than imported ones in Burkina Faso (Harou et al., 2013). Additionally, in times of the COVID-19 crisis, the use of local or regional food aids allows for overcoming trade barriers, which have risen due to pandemic regulations (Cardwell and Ghazalian, 2020).

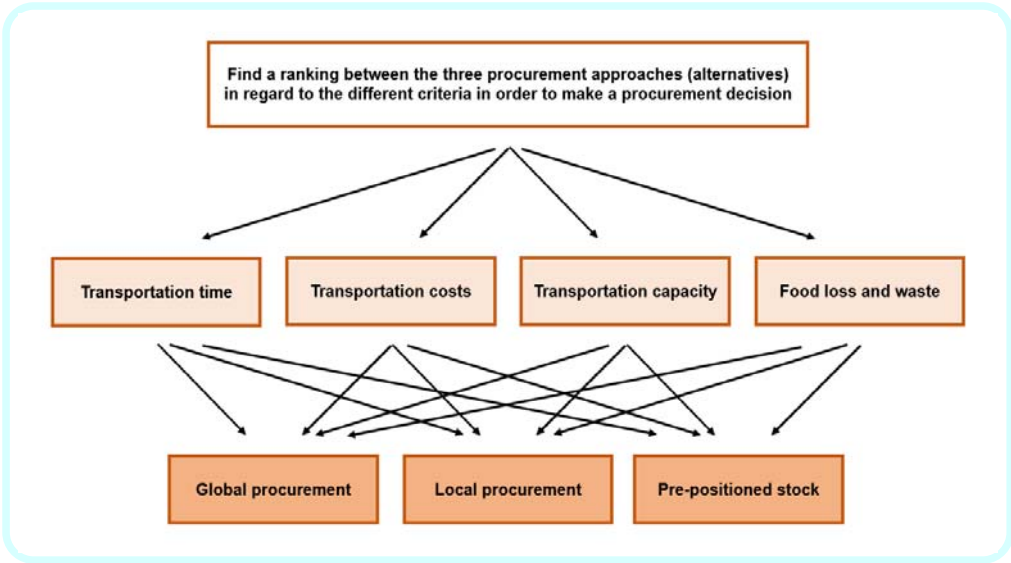
The third approach is the use of PPS. It refers to relief items that are purchased in the preparation of possible disasters and stored in warehouse facilities until they find their way to the beneficiaries (Balcik and Beamon, 2008; Ukkusuri and Yushimito, 2008). The availability of PPS is decisive in a quick response to emergency events (Balcik and Beamon, 2008). It involves a range of relief items from food and non-food items, such as medicine, basic sanitation, and accommodations (e.g., tents). Furthermore, IT and telecommunication equipment are often required (Pan American Health Organization [PAHO], 2001). PPS is further restricted by the transport capacity of the warehouse facilities' location. The availability of necessary transportation modes and developed infrastructures are decisive aspects in using PPS (Roh Sae-Yeon, Jang Hyun-Mi and Han Chul-Hwan, 2013). Additionally, the recipients have dietary and food sourcing preferences that can vary within one population. Consequently, some PPS might not be suitable for certain food assistance (Harou et al., 2013; Lentz et al., 2013; Violette et al., 2013). Finally, political conflicts can cause situations in which affected countries refuse to receive relief aids originating from specific nations (Whybark, 2007).

2. Criteria Influencing the Transport due to a Procurement Decision

According to Beamon and Balcik (2010), response time is the most critical measure of performance because it decides how many people in life-threatening circumstances are saved and supported (Balcik et al., 2010; Beamon and Balcik, 2008; Van Wassenhove, 2006). It is mainly influenced by HO's internal processes, including the procurement of supplies at a specific location and their transportation from the supplier or warehouse to the destination. Additionally, external aspects like topology, given infrastructure, and political conditions affect the transportation time (Beamon and Balcik, 2008). Several studies have concluded that access to sea also significantly impacts the duration of transportation. Transoceanic shipments were mostly received much faster in coastal regions, whereas, in landlocked countries, local food aids were often more time-efficient (Harou et al., 2013; Lentz et al., 2013).

Generally, the overall costs determine how many people in need can Hos support (Harou et al., 2013). Moreover, transportation costs of HOs vary greatly. In Azmat and Kummer (2020), experts mentioned a share of the total costs from 10% to 60% for transport and logistic activities. According to Falasca and Zobel (2011), transportation accounts for 15% of the total costs. Different factors impact shipping costs because of a procurement decision. First, the cost depends on the distance and transport capacity (Azmat and Kummer, 2020; Praneetpholkrang et al., 2021). Additionally, crossing borders leads to high demand for transportation resources. By procuring internationally, relief items must be officially exported and imported, leading to certain transaction costs (Harou et al., 2013; Ozpolat et al., 2015). Another cost factor is the means of carriage, which varies in price and fuel consumption (Praneetpholkrang et al., 2021; Tzeng et al., 2007). Furthermore, the sea access influences the costs. Countries without any waterway are harder to reach, leading to limited channels to import aids and restricted use of transportation

Fig. 2. Fuzzy-AHP Hierarchy



modes (Harou et al., 2013; Lentz et al., 2013). However, the transport costs are on top of the purchasing expenses for the relief items. They vary in every country, and thus, this variation must be considered in choosing a procurement approach. Generally, processed food is often cheaper to source on the global market despite the distance required for transport (Harou et al., 2013).

Transport capacity is another criterion that influences transport and costs. Generally, it depends on the availability of transport means within the whole HSC (Azmat and Kummer, 2020; Tzeng et al., 2007). Fig. 1 shows several steps within the HSC that require the transport of relief items (Balcik and Beamon, 2008). In the case of direct LP and GP, aids are transported from the suppliers to the aid recipients (Balcik and Beamon, 2008). Although global shipping often requires several types of transport, such as overland, by sea and/or air, local transport entails the need for special vehicles (Balcik et al., 2008). Regions that are affected by disasters have lower transport capacities due to a limited number of vehicles available that can manage the last-mile distribution despite weak infrastructural accessibility. Consequently, the last-mile distribution challenges HOs to find suitable transportation systems with enough conveying capacity to reach the destinations (Ozpolat et al., 2015). Transport accessibility is also a factor that must be considered in the location decision of PPS in warehouses. In particular, this concerns waterway connectivity (Roh et al., 2013).

Additionally, the transportation of food requires special handling to avoid spoilage risks (Beamon and Balcik, 2008; Hammond et al., 2015). Consequently, transportation conditions and carriers must be adapted or selected according to the type of food item to prevent food loss and waste (FLW) (Hammond et al., 2015). FLW is further implicated by the transportation time (Hammond et al., 2015), along with the transportation distance. The shorter the distance, the lower the risk for FLW during the transportation stage (Sasaki et al., 2021). Additionally, the origin of food products impacts the extent of FLW, because severe quality differences were found in studies (Harou et al., 2013; Ozpolat et al., 2015). If products are traded directly, LP could also reduce the FLW by avoiding several quality inspections from different supply chain echelons (FAO, 2011).

The result of literature review, a large body of explored HSC and humanitarian logistic. However, it is the lack of that, there were insufficient studies examining it. Therefore, in this study, we will examine

the differences by examining the priorities from the perspective of development assistance and disaster relief and non-governmental organizations (NGOs), including the priority from the perspective of the overall HSC. In the given research, the goal is to find a ranking between the different sourcing methods to come to a procurement decision. The chosen criteria based on the literature review are transportation costs, transportation time, transportation capacity, and FLW. Henceforth, the three procurement approaches, namely, GP, LP, and the use of PPS, will be referred to as the alternatives (Fig. 2).

Ⅲ. Methodology

1. Fuzzy AHP Method

Numerous judgments can be combined to find priorities within the decision-making of a specific group of people (Kahraman et al., 2003), in this case, people working in humanitarian procurement and transport of food items. The tool allows the use of quantitative and qualitative data (Kahraman et al., 2003). Moreover, one does not require many resources to analyze AHP. Apart from a calculation tool (e.g., Excel), individual judgments are needed from questionnaire respondents that match the requirements of the defined sample group (Kahraman et al., 2003). The given research aims to find a ranking between the different sourcing methods for a procurement decision. The chosen criteria are transportation costs, time, and capacity, and FLW. Henceforth, the three procurement approaches are referred to as alternatives.

The same level of relative reference weights can be obtained using pairwise comparisons. We approached a large number of selected experts, who answered the question, "Which criteria should be emphasized more and how much more should be emphasized when considering the impact on food aid procurement decisions?" Linguistic judgments can be converted into triangular fuzzy numbers (TFNs) to compensate for such ambiguity in human language. A fuzzy set $\widetilde{A}$ has an argument x in X, where the membership function $\mu\widetilde{A}(x)$ represents a value between 0 and 1. If $\mu\widetilde{A}(x)=0$ is completely in A, $\mu\widetilde{A}(x)=1$, then x does not belong to A. Also, in the case of $0<\mu\widetilde{A}(x)<1$, it partly belongs to A. The range of TFN is expressed as (l, m, u) and can be defined as follows (Kahraman et al., 2003).

$$M_{ij}=(l_{ij},m_{ij},u_{ij})$$
$$where\ (l,m,u)\ are\ real\nu mbers\ \text{and}\ l\le m\le u. \tag{1}$$

$$l_{ij}=\min(E_{ijk}),\ m_{ij}=\sqrt[n]{\prod_{k=1}^{n}E_{ijk}},\ m_{ij}=\max(E_{ijk}) \tag{2}$$

$$M_1\oplus M_2=(l_1+l_2,m_1+m_2,u_1+u_2) \tag{3}$$

$$M_1\ominus M_2=(l_1-l_2,m_1-m_2,u_1-u_2) \tag{4}$$

$$M_1\otimes M_2=(l_1l_2,m_1m_2,u_1u_2) \tag{5}$$

$$M_1\oslash M_2=(l_1/l_2,m_1/m_2,u_1/u_2) \tag{6}$$

$$M_n \times a = (al_n, am_n, au_n) where\, a > 0 \tag{7}$$

$$M^{-1}_n = (\frac{1}{l_n}, \frac{1}{m_n}, \frac{1}{n_n}) \tag{8}$$

The following are some key fuzzy AHP procedures for extending the AHP approach and concluding the comparative weight of each criterion to provide decision-makers' comparative estimations.

$$\widetilde{A} = \begin{bmatrix} 1 & \tilde{a}_{12} \cdots \tilde{a}_{1n} \\ \tilde{a}_{21} & 1 \quad \cdots \tilde{a}_{2n} \\ \vdots & \vdots \quad \ddots \vdots \\ \tilde{a}_{n1} & \tilde{a}_{n2} \cdots 1 \end{bmatrix} = \begin{bmatrix} 1 & 1/\tilde{a}_{12} \cdots 1/\tilde{a}_{1n} \\ 1/\tilde{a}_{21} & 1 \quad \cdots 1/\tilde{a}_{2n} \\ \vdots & \vdots \quad \ddots \vdots \\ 1/\tilde{a}_{n1} & 1/\tilde{a}_{n2} \cdots 1 \end{bmatrix},$$

$$where\, \tilde{a}_{ij} = \begin{cases} (1/u_i, 1/m_i, 1/l_i); \text{for } \forall\, i < j, \\ (1, 1, 1); \text{for } \forall\, i = j, \\ (l_i, m_i, u_i); \text{for } \forall\, i > j. \end{cases} \tag{9}$$

Additionally, the normalized fuzzy decision-matrix represented by $\widetilde{R}$ is publicized in this way:

$$\widetilde{R} = \left[\tilde{r}_{ij}\right]_{n \times n}, i = 1, 2, \cdots, m; j = 1, 2, \cdots, n \tag{10}$$

The supreme eigenvector or comparative weights and λmax are used to ensure the consistency of the criterion priority. The consistency index (CI) for each matrix order n is then calculated using Eq. (11). Meanwhile, Eq. (13) calculates the consistency ratio (CR) using the CI and random index (RI). The CI and CR are defined as follows:

$$A\, W = \lambda_{\max} w \tag{11}$$

Where w is the major eigenvector of the matrix.

$$CI = \frac{\lambda_{\max} - n}{n - 1} \tag{12}$$

$$CR = \frac{CI}{RI} \tag{13}$$

Where n is the number of respondents in the matrix being compared, and λmax denotes the compare matrix's largest value.

Table 1. Random Index (RI)

Size (n)	1	2	3	4	5	6	7	8
RI	0	0	0.52	0.89	1.11	1.25	1.35	1.40

The decision-maker must review the inventive values in the pairwise compare matrix if CR≤0.1 is regarded fit; otherwise, the decision-maker should assess the inventive values in the pairwise comparison matrix.

Over de-fuzzification, the weights of each criterion must be converted into non-fuzzy values because they are still in the form of fuzzy triangular values. The best non-fuzzy performance (BNP) value in accordance with the center of the range or centroid is commonly recommended for de-fuzzification. A fuzzy number's BNP value is written as:

$$BNP\ value = \frac{[(u-l)+(m-l)]}{3} + l \tag{14}$$

On the basis of the BNP values, the criteria can be evaluated. The criteria with a higher BNP value usually have greater influence than others. This is where the HSC plan is created and the evaluation process is carried out. For HOs and efficient strategic development, the overall priorities generated from pairwise comparison and alternative evaluation might be used.

2. Data Collection

Fuzzy AHP defendants were chosen from a pool of roughly 70 businesses, with directors and operations managers contacted by e-mail to ensure a varied and fair opinion. Ninety surveys were issued between January 3 and February 27, 2022, with 26 usable questionnaires returned by the deadline. NGO personnel accounted for 15 of the replies. Meanwhile, UN agencies and government organizations accounted for five and four of the respondents, respectively. Two of the participants were employed by an international cooperation service provider. A total of 21 responses with a CR of less than 0.1 were received. Thus, 23.3% (21/90) of the restorations were successful. Unlike standard quantitative and parametric statistical procedures, AHP does not require a huge number of samples, and the analysis may be done with less than 10 individuals to assure consistency (Jung, 2015). Therefore, it was determined that the planned study was both valid and suitable in this study. Most responders are executives with at least 8 years of experience in the HO or disaster relief sections, demonstrating that they are well-versed in the field (See Table 2).

Table 2. Respondents Profiles

Organization	Number	Work Experience	Number
NGO	11	Below 5	2
UN agency	4	5-10	5
Gvernment organization	4	10-20	10
International cooperation service provider	2	Over 20	4

Ⅳ. Findings

Respondents were asked to construct pairwise comparisons of the four main criteria and four alternatives by using linguistic variables. The CR of all matrices is less than 0.1, indicating that these matrices are sufficiently consistent. Then, the linguistic expressions were transformed into TFNs and

a fuzzy evaluation matrix was established. Using the geometric mean, the pairwise comparison matrices of the criteria and alternatives are established. The results from the computations using the pairwise comparison matrices are shown in Tables 3 and 7. In the same way, the fuzzy comparison matrices of focusing on development assistance/disaster relief and NGO can also be obtained.

Table 3. Fuzzy Comparison Matrix of the Main Criteria

Main criteria	Time	Cost	Capacity	FLW
Time	(1, 1, 1)	(2.091, 2.365, 2.610)	(1.538, 1.908, 2.209)	(0.545, 0.629, 0.734)
Cost	(0.383, 0.423, 0.478)	(1, 1, 1)	(1.063, 1.221, 1.380)	(0.556, 0.608, 0.669)
Capacity	(0.453, 0.524, 0.650)	(0.724, 0.819, 0.941)	(1, 1, 1)	(0.586, 0.648, 0.726)
FLW	(1.362, 1.591, 1.834)	(1.494, 1.646, 1.800)	(1.377, 1.544, 1.706)	(1, 1, 1)

Table 4. Fuzzy Comparison Matrix of Transportation Time

Alternatives	GP	LP	PPS
GP	(1, 1, 1)	(0.432, 0.501, 0.573)	(0.401, 0.478, 0.556)
LP	(1.745, 1.995, 2.316)	(1, 1, 1)	(1.060, 1.203, 1.342)
PPS	(1.799, 2.093, 2.496)	(0.745, 0.831, 0.943)	(1, 1, 1)

Table 5. Fuzzy Comparison Matrix of Transportation Costs

Alternatives	GP	LP	PPS
GP	(1, 1, 1)	(0.519, 0.570, 0.628)	(0.681, 0.784, 0.921)
LP	(1.592, 1.754, 1.926)	(1, 1, 1)	(1.899, 2.246, 2.545)
PPS	(1.086, 1.276, 1.469)	(0.393, 0.445, 0.527)	(1, 1, 1)

Table 6. Fuzzy Comparison Matrix of Transportation Capacity

Alternatives	GP	LP	PPS
GP	(1, 1, 1)	(0.682, 0.817, 0.977)	(0.539, 0.686, 0.874)
LP	(1.024, 1.224, 1.467)	(1, 1, 1)	(0.518, 0.626, 0.790)
PPS	(1.144, 1.459, 1.854)	(1.295, 1.598, 1.931)	(1, 1, 1)

Table 7. Fuzzy Comparison Matrix of FLW

Alternatives	GP	LP	PPS
GP	(1, 1, 1)	(0.425, 0.487, 0.567)	(0.534, 0.623, 0.725)
LP	(1.762, 2.054, 2.353)	(1, 1, 1)	(1.534, 1.831, 2.167)
PPS	(1.380, 1.604, 1.872)	(0.461, 0.546, 0.652)	(1, 1, 1)

1. The Results of Criteria and Alternatives Analysis

Based on the fuzzy AHP results, Table 8 shows the weights of each criterion and component. All CR values are below 0.1, suggesting that they passed the consistency test. FLW (0.323) is the most important factor impacting the purchase choice, followed by transportation time (0.300), transportation expenses (0.194), and transportation capacity (0.191). In terms of alternatives (see Table 9), LP (0.399), PPS (0.346), and GP (0.268) were the most critical for HOs.

Table 8. Results of Fuzzy-AHP

Main criteria	CR	Weight	BNP	Rank
Time	0.031	(0.252, 0.299, 0.350)	0.300	2
Cost		(0.167, 0.192, 0.223)	0.194	3
Capacity		(0.162, 0.188, 0.223)	0.191	4
FLW		(0.276, 0.321, 0.371)	0.323	1

`

Table 9. Final Ranking according to the Composite Weight

Alternatives	Time	Cost	Capacity	FLW	Composite	Rank
GP	0.246	0.280	0.297	0.259	0.268	3
LP	0.391	0.430	0.317	0.427	0.399	1
PPS	0.368	0.294	0.395	0.320	0.346	2
CR	0..01	0.05	0.02	0.04		

2. Focus on Development Assistance and Disaster Relief

Additionally, we examined whether a difference exists in each alternative and variables from the perspective of development assistance and disaster relief and NGOs. That is, fuzzy AHP data are analyzed according to the purpose of the participating organizations' department.

Among the 26 participants, six are specialized in development assistance, and five have their background in disaster relief. Finally, six respondents provide both assistance types. After examining the data sets using the AHP examination, this study obtained the following composite weights. According to the composite weight distribution of all three divisions, the ranking of the procurement approaches regarding the four criteria is similar to that of all respondents in Table 10 and 11. LP is ranked first, whereas PPS takes second place.

One striking aspect of the composite weighting is that transportation time was the most important for development assistance and disaster relief respondents. The high importance of time can be due to the time-sensitivity of disaster relief, in which the response time decides about the number of humans saved (Balcik et al., 2010; Beamon and Balcik, 2008; Van Wassenhove, 2006). Additionally, LP and PPS have almost the same degree of sourcing preference with shares of 38% and 35%, respectively. In all cases, GP is by far the most unfavored sourcing type. This could be explained by the nature of food aids, which entails the risk of deterioration. Consequently, different transportation standards and delivery times are required for food aids (Tanner, 2016).

Table 10. Results of Fuzzy-AHP in Development Assistance and Disaster Relief Perspective

Main criteria	CR	Weight	BNP	Rank
Time	0.012	(0.266, 0.306, 0.346)	0.306	1
Cost		(0.192, 0.216, 0.243)	0.217	3
Capacity		(0.182, 0.205, 0.236)	0.208	4
FLW		(0.245, 0.273, 0.305)	0.275	2

Table 11. Final Ranking according to the Composite Weight in Development Assistance and Disaster Relief Perspective

Alternatives	Time	Cost	Capacity	FLW	Composite	Rank
GP	0.271	0.295	0.278	0.270	0.279	3
LP	0.361	0.394	0.357	0.400	0.380	1
PPS	0.369	0.312	0.369	0.332	0.348	2
CR	0.03	0.02	0..01	0..01		

3. Focus on NGO

The results show that the NGOs' perspective contradicts the overall and the previous results. One surprising aspect of the aggregate weighting is that NGO respondents did not consider transportation costs as a top priority. Additionally, in terms of alternatives, PPS is by far the most unfavored sourcing type. This could be due to the strong cost intensity of the holding of PPS. NGOs might not have sufficient funds to store food items in advance like big HOs have (Balcik et al., 2010). Additionally, the nature of food aids aggravates the long-term storage because of its risk of deterioration (Tanner, 2016). The finding that LP is the preferred sourcing approach is consistent with the feedback received from most HOs during the contact phase.

Table 12. Results of Fuzzy-AHP in NGO Perspective

Main criteria	CR	Weight	BNP	Rank
Time	0.042	(0.252, 0.299, 0.350)	0.277	2
Cost		(0.167, 0.192, 0.223)	0.200	4
Capacity		(0.162, 0.188, 0.223)	0.208	3
FLW		(0.276, 0.321, 0.371)	0.318	1

Table 13. Final Ranking according to the Composite Weight in NGO Perspective

Alternatives	Time	Cost	Capacity	FLW	Composite	Rank
GP	0.253	0.285	0.293	0.255	0.269	2
LP	0.397	0.433	0.345	0.448	0.411	1
PPS	0.352	0.283	0.364	0.299	0.325	3
CR	0.02	0.04	0.03	0.03		

V. Concluding Remarks

The given research has investigated LP and GP and the use of PPS concerning the transportation of food aids. Four criteria were considered within the analysis: transportation time, transportation costs, transportation capacity and FLW. Data were collected using a web questionnaire that provided the basis for the analysis with the multi-criteria tool fuzzy AHP.

The fuzzy AHP results reveal that the preferred procurement approach, considering the four criteria studied, is LP, followed by the use of PPS, and GP takes last place. The cross-comparisons concluded that HSC departments focusing on development assistance assigned a very similar share to PPS and LP. However, in disaster relief, LP was by far the most favored sourcing method. This dynamic was found even stronger in the evaluation of NGOs, in which PPS is ranked much lower than LP. This can be explained by the fact that most NGOs operating on a medium-sized level or lower cannot afford PPS. Meanwhile, the unpopularity of GP could be explained by the risk of deterioration of food items leading to more difficult transportation requirements. Most HOs do not have the organizational structures to purchase and handle relief aids, particularly food items on their own. This is because they either work with external partners on-site or depend on the operations division of their headquarters while concentrating on advocacy work and marketing in their location to raise donations. These results support the aforementioned study by Lentz et al. (2013). In other words, employing LP saves around 14 weeks of time and enhances cost efficiency by more than 50% on average, particularly for grains. There appears to be a substantial benefit in keeping, even growing, the larger toolset given by an LP option and offering operational agencies the freedom to choose any of many delivery modalities in both development assistance/disaster relief and NGO contexts. Of course, this implies that operational agencies must acquire and maintain the ex-ante analysis and ex-post monitoring and evaluation capabilities required to exercise responsibility such extended choice-individually and/or collectively (Maxwell et al., 2013).

The results give some suggestions and implications for both the HOs and academics. Regarding industrial implications, both development assistance and disaster relief managers and NGOs can benefit from this paper. For development assistance and disaster relief managers, (1) by examining the impact of procurement decisions on the transport of food aid in HOs, four criteri9a and improved conclusions may be drawn: transport time, transport cost, transport capacity, and FLW. (2) Due to the time-sensitive nature of disaster relief, where the number of people rescued determines the response time, finding a way to increase the efficiency of HSC through LP to prevent FLW and reduce transportation time is necessary. In addition, NGOs that may not have sufficient funds to pre-store food HOs may be cost-intensive to hold PPS. Consequently, we will need to pay more attention to FLW than to envelopment assistance and disaster relief.

Several implications for future research were found during the analysis. For the survey respondents, the first suggestion is to scale up the dataset with more respondents. Simultaneously, a clear differentiation of answers from people working in disaster relief or development activities would reinforce the comparisons between the assistance types, leading to a clear separation of recommendations for action. Beyond that, a division between non-perishable and perishable food items provides further insights into their respective supply chain dynamics. Second, the reasons for procuring food aids at a specific location should be further investigated by looking at the strengths and weaknesses of the sourcing type. How these weaknesses can be compensated is yet to be solved. Moreover, one of the biggest challenges in humanitarian transport is accomplishing the last-mile delivery. Consequently, this should be particularly examined regarding the transportation time and associated costs, taking the presented findings into account. This goes along with the aspect of building a strong supplier network and cooperation with regional partners.

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