14th Annual International Conference on Industrial Engineering and Operations Management
Dubai, United Arab Emirates (UAE), February 12-14, 2024
Publisher: IEOM Society International, USA DOI: 10.46254/AN14.20240129
Published: February 12, 2024

Air Freight Specialist Evaluation with F-AHP-TOPSIS

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Abstract

Supervising the logistics and operations associated with air cargo transportation requires the expertise of an air freight specialist. In evaluation of an air freight specialists, several potentially conflicting quantitative and qualitative criteria needs to be taken into consideration, therefore a multicriteria decision making method (MCDM) is needed. In this research, Fuzzy Analytical Hierarchical Process (F-AHP) and Fuzzy Technique for Order Preference by Similarity to Ideal Solution (F-TOPSIS) are integrated (F-AHP-TOPSIS) for assessment of airfreight specialist candidates of DHL Global Forwarding company. 15 criteria are determined with the help of 5 specialists acting as decision makers (DMs), and at first F-AHP is applied to determine criteria weights. Afterwards, utilizing these obtained weights, F-TOPSIS is implemented to rank 5 air freight specialist candidates.

Keywords
MCDM, fuzzy AHP, fuzzy TOPSIS, air freight specialist selection

1. Introduction
In a globally integrated business environment, logistics and air freight play significant roles. Efficient employee selection is essential for global companies since personnel and the working environment directly affect performance and productivity. An air freight specialist supervises the logistics and operations related with air cargo transportation. Responsibilities of the job include; regulations, tracking the goods, negotiating prices with airlines, documentation formatting, providing customer service and preparing internal presentations. Therefore, there are several substantial criteria to take into consideration while determining the best air freight specialist candidate.

In this research, a global logistics company, DHL Global Forwarding's air freight specialist candidate evaluation and selection process is studied. Due to the existence of various competing criteria in the decision process, an integrated MCDM method, namely F-AHP-TOPSIS is utilized to have both methods' benefits. F-TOPSIS is easy to implement and provides stable results with a little effort, however in F-TOPSIS, guidelines to determine criteria weights are not specified. Therefore, a logical method such as F-AHP is required to obtain consistent, reliable criteria weights. Conversely, F-AHP, without integration with F-TOPSIS becomes burdensome, especially when there are too many alternatives and criteria since then DMs need to do large number of pairwise comparisons. With F-AHP-TOPSIS, air freight specialist alternatives can be ranked in a rational time, without too many complicated pairwise comparisons and calculations (Samanlioglu et al. 2018). Moreover, in F-AHP- TOPSIS, uncertainty and vagueness of assessments of DMs are captured with the help of linguistic variables and "fuzzy set theory" (Zadeh 1965; Zadeh 1994; Lootsma 1997).

In F-AHP-TOPSIS, first, F-AHP is applied to compute weights of assessment criteria and then F-TOPSIS is implemented to rank air freight specialist candidates from best to worst, utilizing the obtained weights.

2. Literature Review

AHP is a MCDM method with "multi-level, hierarchical structure" (Saaty 1980). In AHP, weights of criteria are calculated with pairwise evaluations and then alternatives are assessed with respect to each criterion. As a result, a total weighted score is determined for each alternative and alternatives are ranked based on this score, with the highest score being the best. To capture the uncertainty and vagueness of DMs, its fuzzy version, F-AHP was successfully applied to various MCDM problems in the literature such as evaluation of timetables in transportation (Isaai et al. 2011), assessment of manufacturing partners in integrated manufacture planning (Jung 2011), supplier selection in supply chain (Shaw et al. 2012), evaluation of academic staff (Eran 2012), selection problems in process engineering (Tan et al. 2014), assessment of the university business incubators (Somsuk and Laosirihongthong 2014), selection of industrial engineering sector (Akkaya et al. 2015), outsourcing reverse logistic (Tavana et al. 2016), evaluating the feasibility of block chain in logistics operations (Ar et al. 2020), and identifying challenges in "Cloud-Based Outsource Software Development (COSD)" projects (Akbar et al. 2020).

TOPSIS was developed by Hwang and Yoon (1981) based on the concept that the ideal solution will be at the shortest distance to positive-ideal solution (PIS) and at the furthest distance to the negative ideal-solution (NIS). Further developments of TOPSIS was given by Yoon (1987) and Hwang et al. (1993). Fuzzy extension of TOPSIS, F-TOPSIS was implemented in various areas such as selection of plant locations (Yong 2006), assessment of bridge risks (Wang and Elhag 2006), evaluation of cement firms in stock exchange (Ertugrul and Karakasoglu 2009), and supplier selection in a watch firm (Liao and Kao 2011).

In the literature, F-AHP-TOPSIS was utilized in several applications. In these papers, generally F-AHP is implemented to determine criteria weights and then F-TOPSIS is applied, utilizing these weights, to rank alternatives. Some of these applications are: Personnel selection (Fathi et al. 2011), performance analysis of hospital managers (Shafii et al. 2016), assessing safety conditions at work sites in construction industry (Basahel and Taylan 2016), third party logistics (3PL) selection for cold chain management (Singh et al. 2017), prioritizing the solutions of lean implementation in small and medium enterprises (Belhadi et al. 2017), IT personnel selection (Samanlioglu et al.2018), financial performance evaluation of Turkish Airline companies (Perçin and Aldalou 2018), evaluation of outsource manufacturers (Kahraman et al. 2018), assessing the human resource in science and technology for Asian countries (Chou et al. 2019), selecting the best color removal process using carbon-based adsorbent materials (Azari et al. 2020), wind turbine evaluation (Beskese et al. 2020), wire electric discharge machining process assessment (Fuse et al.2021), aquaculture species selection (Padma et al. 2022), and mercury risk reduction in artisanal and small-scale gold mining (Alhassan et al. 2023).

Previously in the literature, F-AHP-TOPSIS was applied to select IT personnel selection (Samanlioglu et al. 2018) and human resource manager selection (Kusumawardani and Agintiara 2015). Currently, to the best of authors' knowledge, in the literature, there is no research paper that focuses on air freight specialist evaluation and selection. The main motivation of this research is to provide a systematic methodology to potential practitioners and readers for assessment of air freight specialist candidates of logistics companies.

3. F-AHP-TOPSIS Method

A "fuzzy number" is a special "fuzzy set" $F = \{(x, \mu_F(x)), x \in R\}$ where x is a real number, $R: -\infty < x < +\infty$ and $\mu_F(x)$ is from R to [0, 1]. In this research, "triangular fuzzy numbers (TFN)" are implemented due to its simplicity in F-AHP-TOPSIS. A TFN, $\tilde{M} = (l, m, u)\ \ l \leq m \leq u$ has the "triangular type membership function";

$$\mu_F(x) = \begin{cases} 0 & x < l \\ (x-l)/(m-l) & l \leq x \leq m \\ (u-x)/(u-m) & m \leq x \leq u \\ 0 & x > u \end{cases} \tag{1}$$

Arithmetic operations with TFNs are previously given in several research papers (Wu and Xu 2016; Samanlioglu and Ayağ 2020). If $\tilde{B} = (l, m, u)$ is a positive TFN, $\tilde{B}$ can be defuzzified with "graded mean approach" as (Kwong and Bai 2003; Yong 2006):

$$B = (l + 4m + u)/6 \tag{2}$$

In F-AHP-TOPSIS, *k* number of DMs do pairwise comparison of criteria and also assess each alternative with respect to each criterion utilizing the linguistic terms presented in Table 1. These linguistic assessments of k DMs are converted to TFNs using the scale presented in Table 1 and then as part of group decision-making, taking average of TFNs of k DMs, aggregated fuzzy pairwise comparison matrix of criteria ($\widetilde{A}$) (based on pairwise assessment of *n* criteria) in F-AHP part and aggregated fuzzy decision matrix ($\widetilde{D}$) (based on assessment of *m* alternatives with respect to *n* criteria) in F-TOPSIS part are obtained.

Table 1. Assessment scale in F-AHP-TOPSIS

Linguistic terms	TFN
Very Poor (VP)	(0,0,1)
Poor (P)	(0,1,3)
Medium Poor (MP)	(1,3,5)
Fair (F)	(3,5,7)
Medium Good (MG)	(5,7,9)
Good (G)	(7,9,10)
Very Good (VG)	(9,10,10)

F-AHP (Samanlioglu and Ayağ 2017; Samanlioglu and Ayağ 2020) part of F-AHP-TOPSIS is used to determine criteria weights. Elements of aggregated pairwise comparison matrix $\tilde{A}$ is defuzzified with Eq. (2) and the defuzzified *nxn* pairwise comparison matrix A is obtained. $w = (w_1, w_2, \dots, w_n)$ (crisp weights) is computed by averaging the elements on each row of normalized A. So the "normalized principal eigen vector" is w. From $Aw = \lambda_{\max} w$, the "principal eigen value" (λ_{max}) is calculated and the "consistency index" (*CI*) is computed as: $CI = (\lambda_{max} - n)/(n - 1)$. Then, consistency ratio (CR) is computed as *CR=CI/RI*, where *RI* is "random index" that is based on matrix size. If the $CR < 0.10$, the comparison is consistent, otherwise it is not (Saaty, 1980).

In F-TOPSIS (Chen 200; Samanlioglu et al. 2018) part of F-AHP-TOPSIS, alternatives are ranked from best to worst, utilizing the weights $w = (w_1, w_2, \dots, w_n)$ obtained from F-AHP part. Aggregated fuzzy decision matrix $\widetilde{D}$ is normalized and normalized decision matrix $\tilde{R}$ is obtained as follows:

$$\tilde{R} = [\tilde{r}_{ij}]_{mxn} \; where \; \tilde{r}_{ij} = \left(\frac{a_{ij}}{c_j^*}, \frac{b_{ij}}{c_j^*}, \frac{c_{ij}}{c_j^*}, \right), c_j^* = {}^{max}_{\;\;i} \; c_{ij} \text{ if } j \; is \; a \; benefit \; criterion, \tag{3}$$
$$and \;\; \tilde{r}_{ij} = \left(\frac{a_j^-}{c_{ij}}, \frac{a_j^-}{b_{ij}}, \frac{a_j^-}{a_{ij}}, \right), a_j^- = {}^{min}_{\;\;i} \; a_{ij}, if \; j \; is \; a \; cost \; criterion$$

Afterwards, weighted normalized fuzzy decision matrix $\tilde{V}$ is computed as $\tilde{V} = [\tilde{v}_{ij}]_{mxn} \; and \; \tilde{v}_{ij} = \tilde{r}_{ij}.w_j$, where w_j are the weights obtained with F-AHP. Fuzzy Positive Ideal Solution (FPIS) $A^* = (v_1^*, v_2^*, v_3^*, \dots, v_n^*)$ and Fuzzy Negative Ideal Solution (FNIS) $A^- = (v_1^-, v_2^- v_3^-, \dots, v_n^-)$ are defined. In this research, $v_j^* = (1,1,1)$ and $v_j^- = (0,0,0)$, $j = 1,2,3,\dots,n$ since all the criteria are benefit criteria. Distance of each alternative from A^* (d_i^*) and from A^- (d_i^-) are calculated with the vertex method in Eq. (4). Note that, based on the vertex method, the distance between 2 positive TFNs $\tilde{m} \; and \; \tilde{n}$ is computed as $d(\tilde{m}, \tilde{n}) = \sqrt{\frac{1}{3}[(m_1 - n_1)^2 + (m_2 - n_2)^2 + (m_3 - n_3)^2}$.

$$d_i^* = \sum_{j=1}^{n} d(\tilde{v}_{ij}, \tilde{v}_{ij}^*) \forall_i, d_i^- = \sum_{j=1}^{n} d(\tilde{v}_{ij}, \tilde{v}_{ij}^-) \; \forall_i \tag{4}$$

Next, closeness coefficient CC_i of each alternative is calculated as:

$$CC_i = \frac{d_i^-}{d_i^- + d_i^*} \forall_i \tag{5}$$

Consequently, alternatives are ranked from best to wors according to decreasing CC_i. If CC_i is closer to 1, alternative i is closer to A*.

4. Application and Results

Here a case study of a logistics company, DHL Global Forwarding, is presented where 5 air freight specialist candidates (A1,…,A5) are evaluated based on 15 benefit criteria (C1,…,C15) by 5 DMs. The DMs from DHL Global Forwarding Company are the Head of Logistics of Turkey (DM1), Air Freight Department Head of Turkey (DM2), Team Leader of Air Freight Department (DM3), Head of Human Resources Department (DM4), and Human Resources Specialist (DM5). 15 benefit criteria are: Use of ERP Skills (C1), Certifications (C2), Knowledge of Incoterms (C3), Documentation Formatting Knowledge (C4), Time Management (C5), Critical Thinking (C6), Knowledge of Commodities (C7), Crisis Management (C8), Use of Social Skills (C9), Communication Skills (C10), Experience of Operation Softwares (C11), Application of Legal Regulations (C12), Graduated Schools (C13), Basic MS Office Knowledge (C14), and Language Skills (C15).

In F-AHP-TOPSIS, at first, 5 DMs make pairwise assessments of criteria with the linguistic terms shown in Table 1 as seen in Table 2. Based on the scale presented in Table 1, these terms are converted to TFNs. Taking average of the TFNs of DMs, aggregated fuzzy pairwise comparison matrix of criteria $\widetilde{\boldsymbol{A}}$ is obtained. Defuzzifying elements of $\widetilde{\boldsymbol{A}}$ with Eq. (2), defuzzified aggregated pairwise comparison matrix A in Table 3 is determined. $\boldsymbol{w} = (\boldsymbol{w_1}, \boldsymbol{w_2}, \dots, \boldsymbol{w_n})$ is computed by averaging the elements on each row of normalized $\boldsymbol{A}$ and *w* is also presented in Table 3. From $\boldsymbol{Aw} = \boldsymbol{\lambda_{\max} w}$, the "principal eigen value" is computed as $\boldsymbol{\lambda_{max}}$=15.7, so consistency index is calculated as $\boldsymbol{CI} = \boldsymbol{(15.7 - 15)/(15 - 1)}$=0.05. Consistency ratio is determined as *CR=CI/RI=0.05/1.58=0.0316*, since *RI*=1.58 when n=15. Since *CR=0.0316 < 0.10*, the comparison is consistent.

Table 2. Pairwise comparison of criteria by 5 DMs

C	C1	C2	C3	C4	C5	C6	C7	C8
C1	F,F,F,F,F	G,VP,VG,VP,MG	G,VP,F,VP,G	VG,VP,VP,MG,VG	VG,F,VP,VP,VG	VG,P,VP,VG,VG	MG,VP,VP,P,G	F,VP,VG,MP,MG
C2	P,VG,VP,VG,MP	F,F,F,F,F	F,VP,VP,VP,MG	G,VP,F,VG,VG	VG,MG,P,VP,VG	G,VP,P,VG,VG	F,MG,MG,VP,MG	F,VP,MG,P,F
C3	P,VG,F,VG,P	F,VG,VG,VG,MP	F,F,F,F,F	G,VP,MG,VG,G	VG,MG,VG,VP,VG	G,VP,VG,VG,VG	F,MG,VP,VP,F	F,VP,G,VP,VP
C4	VP,VG,VG,MP,VP	P,VG,F,VP,VP	P,VG,MP,VP,P	F,F,F,F,F	G,G,VG,MP,G	MG,VP,F,MG,VG	F,G,VP,MP,VP	F,MG,MG,MP,VP
C5	VP,F,VG,VG,VP	VP,MP,G,VG,VP	VP,MP,VP,VG,VP	P,P,VP,MG,P	F,F,F,F,F	F,VP,G,VG,G	F,F,F,VP,VP	F,VP,MG,VP,P
C6	VP,G,VG,VP,VP	P,VG,G,VP,VP	P,VG,VP,VP,VP	MP,VG,F,MP,VP	F,VG,P,VP,P	F,F,F,F,F	F,VG,VP,MP,P	F,MG,G,F,MP
C7	MP,VG,VG,G,P	F,MP,MP,VG,MP	F,MP,VG,VG,F	F,P,VG,MG,VG	F,F,F,VG,VG	F,VP,VG,MG,G	F,F,F,F,F	F,MG,G,F,VP
C8	F,VG,VP,MG,MP	F,VG,MP,G,F	F,VG,P,VG,VG	F,MP,MP,MG,VG	F,VG,MP,VG,G	F,MP,P,F,MG	F,MP,P,F,VG	F,F,F,F,F
C9	VP,VG,VG,G,VP	MP,VG,MP,VG,VP	MP,VG,MP,VG,P	F,F,MP,MG,MP	F,VG,VP,VG,MP	F,F,MP,F,F	P,VG,MP,VG,P	VP,VG,VG,MP,VP
C10	P,G,F,VG,VP	F,VG,P,VG,P	F,VG,P,F,MP	F,VG,VP,VG,F	F,G,MP,MP,F	F,VG,P,G,VG	MP,G,MP,MP,MP	P,VG,F,P,P
C11	VP,VG,MP,G,VP	MP,VG,F,VG,VP	MP,VG,VP,VG,P	F,VG,P,MG,MP	F,G,P,VG,MP	F,VG,MP,MG,F	P,G,MP,VG,P	VP,VG,F,F,VP
C12	VP,G,MP,VG,VP	P,G,P,VG,VP	P,G,P,VG,VP	MP,VG,VP,G,P	F,MG,VP,F,MP	MP,VG,P,MG,F	VP,MG,MP,F,VP	VP,VG,F,MP,VP
C13	P,VG,VP,VG,P	F,VG,P,VG,MP	F,VG,VP,F,F	F,VG,P,VG,VG	F,G,MP,MP,VG	F,VG,VP,G,G	MP,G,P,MP,F	P,VG,F,P,F
C14	P,VG,VG,MG,VP	MP,VG,F,G,P	MP,VG,P,VG,MP	F,VG,MP,MG,F	F,G,MP,VG,VG	F,VG,VP,F,VG	P,G,P,F,MP	VP,VG,F,F,P
C15	VP,MG,P,G,VP	MP,G,P,VG,VP	MP,G,VP,VG,P	MP,G,VP,MG,MP	F,MG,MP,VG,F	MP,VG,P,MG,VG	VP,MG,P,VG,P	VP,G,F,MP,VP

C	C9	C10	C11	C12	C13	C14	C15
C1	VG,VP,VP,P,VG	G,P,F,VP,VG	VG,VP,MG,P,VG	VG,P,MG,VP,VG	G,VP,VG,VP,G	G,VP,VP,MP,VG	VG,MP,G,P,VG
C2	MG,VP,MG,VP,VG	F,VP,G,VP,G	MG,VP,F,VP,VG	G,P,G,VP,VG	F,VP,G,VP,MG	MG,VP,F,P,G	MG,P,G,VP,VG
C3	MG,VP,MG,VP,G	F,VP,G,F,MG	MG,VP,VG,VP,G	G,P,G,VP,VG	F,VP,VG,F,F	MG,VP,G,VP,MG	MG,P,VG,VP,G
C4	F,F,MG,MP,MG	F,VP,VG,VP,F	F,VP,G,MP,MG	MG,VP,VG,P,G	F,VP,G,VP,VP	F,VP,MG,MP,F	MG,P,VG,MP,MG
C5	F,VP,VG,VP,MG	F,P,MG,MG,F	F,P,G,VP,MG	F,MP,VG,F,MG	F,P,MG,MG,VP	F,P,MG,VP,VP	F,MP,MG,VP,F
C6	F,F,MG,F,F	F,VP,G,P,VP	F,VP,MG,MP,F	MG,VP,G,MP,F	F,VP,VG,P,P	F,VP,VG,F,VP	MG,VP,G,MP,VP
C7	G,VP,MG,VP,G	MG,P,MG,MG,MG	G,P,MG,VP,G	VG,MP,MG,F,VG	MG,P,G,MG,F	G,P,G,F,MG	VG,MP,G,VP,G
C8	VG,VP,VP,MG,VG	G,VP,F,G,G	VG,VP,F,F,VG	VG,VP,F,MG,VG	G,VP,F,G,F	VG,VP,F,F,G	VG,P,F,MG,VG
C9	F,F,F,F,F	F,VP,MG,MG,F	F,VP,MG,VP,MG	MG,VP,MG,MG,VG	F,VP,MG,MP,VP	F,VP,MG,P,MP	MG,P,MG,MP,MP
C10	F,VG,MP,MP,F	F,F,F,F,F	MG,G,VP,VG,F	G,VP,F,VP,F	F,G,VP,VP,MP	MG,G,VP,VP,MP	MG,VP,MG,VP,VP
C11	F,VG,MP,VG,MP	MP,P,VG,VP,F	F,F,F,F,F	MG,VG,MG,MG,F	G,F,MG,VG,MP	VG,F,F,VP,MP	F,P,MG,VP,F
C12	MP,VG,MP,MP,VP	P,VG,F,VG,F	MP,VP,MP,MP,F	F,F,F,F,F	G,VG,VP,VP,MP	MG,VG,F,VP,MP	F,VP,VP,VP,MP
C13	F,VG,MP,MG,VG	F,P,VG,VG,MG	P,F,MP,VP,MG	P,VP,VG,VG,MG	F,F,F,F,F	F,F,VP,VP,VP	G,P,MG,VP,MG
C14	F,VG,MP,G,MG	MP,P,VG,VG,MG	VP,F,F,VG,MG	MP,VP,F,VG,MG	F,F,VG,VG,VG	F,F,F,F,F	VG,P,G,VP,VG
C15	MP,G,MP,MG,MG	MP,VG,MP,VG,VG	F,G,MP,VG,F	F,VG,VG,VG,MG	P,G,MP,VG,MP	VP,G,P,VG,VP	F,F,F,F,F

Table 3. Defuzzified aggregated pairwise comparison matrix of criteria *A* and obtained weights of criteria (*w)*

	C1	C2	C3	C4	C5	C6	C7	C8	C9	C10	C11	C12	C13	C14	C15	*w*
C1	5.000	5.200	4.600	5.400	5.000	6.167	3.467	5.000	4.233	5.000	5.600	5.600	5.567	4.400	6.533	0.180
C2	0.076	5.000	2.500	6.733	5.600	5.967	5.233	3.667	4.833	4.600	4.433	5.767	4.233	4.433	5.400	0.134
C3	1.044	0.172	5.000	6.933	7.333	7.700	3.467	2.867	4.633	5.200	5.200	5.767	5.000	4.633	5.400	0.132
C4	0.137	0.140	0.129	5.000	7.867	5.800	3.433	4.433	5.400	4.033	4.800	5.400	2.867	4.033	5.600	0.094
C5	0.150	0.248	0.111	0.174	5.000	6.533	3.067	2.700	4.433	5.033	4.433	5.967	4.067	2.700	4.033	0.072
C6	0.239	0.241	0.117	0.155	0.142	5.000	3.833	5.767	5.400	3.067	4.033	4.800	3.467	4.033	3.833	0.066
C7	0.262	0.164	0.181	0.217	0.194	0.325	5.000	5.200	5.000	5.833	5.200	6.933	5.800	6.167	6.133	0.073
C8	0.210	0.292	0.165	0.225	0.283	0.222	0.171	5.000	5.400	6.333	5.967	6.367	5.567	5.767	6.567	0.063
C9	0.252	0.146	0.148	0.228	0.159	0.200	0.142	0.137	5.000	4.833	3.867	6.200	3.067	3.267	4.233	0.041
C10	0.264	0.155	0.171	0.172	0.288	0.243	0.262	0.145	0.177	5.000	6.167	3.833	3.433	3.833	2.900	0.035
C11	0.248	0.159	0.139	0.213	0.273	0.232	0.253	0.159	0.168	0.149	5.000	7.167	6.733	4.600	3.667	0.035
C12	0.248	0.244	0.244	0.250	0.219	0.213	0.197	0.146	0.142	0.175	0.151	5.000	4.400	5.000	1.700	0.024
C13	0.133	0.162	0.181	0.165	0.279	0.385	0.269	0.164	0.223	0.217	0.200	0.194	5.000	2.100	4.833	0.019
C14	0.194	0.273	0.148	0.232	0.283	0.172	0.262	0.162	0.334	0.203	0.223	0.210	0.152	5.000	5.967	0.018
C15	0.293	0.250	0.250	0.308	0.232	0.203	0.184	0.257	0.372	0.159	0.292	0.227	0.260	0.241	5.000	0.014

Afterwards, 5 DMs evaluate each alternative with respect to each criterion with the linguistic terms shown in Table 1 as seen in Table 4. Then, based on the scale presented in Table 1, these terms are converted to TFNs. Taking average of the TFNs of DMs, aggregated fuzzy decision matrix $\widetilde{D}$ is obtained.

Table 4. Evaluation of alternatives with respect to criteria by 5 DMs

	C1	C2	C3	C4	C5	C6	C7	C8
A1	MG,F,MG,G,MG	G,MG,MG,VG,G	MG,F,G,G,MG	F,MP,F,MG,MP	P,VP,MP,MP,F	VG,G,G,VG,F	MG,F,G,G,G	MP,P,MG,F,MG
A2	G,MG,VG,VG,VG	MG,P,F,G,MG	G,MG,VG,VG,G	VG,G,MG,G,F	F,MP,G,MG,VG	G,MG,G,VG,G	MP,P,MG,F,F	F,MP,G,MG,MG
A3	F,MP,G,MG,VG	VG,G,G,G,MG	G,MG,VG,VG,G	MG,F,MG,G,G	VG,G,VG,VG,G	MG,F,MG,G,MG	G,MG,G,VG,VG	MP,P,MG,F,G
A4	MP,P,MP,F,F	G,MG,MG,VG,G	F,MP,F,MG,F	G,MG,VG,VG,VG	MG,F,VG,G,G	MP,P,MG,G,MG	VG,G,G,G,VG	G,MG,G,VG,MG
A5	MP,P,P,F,MP	VG,VP,G,VG,MG	MG,F,VG,G,G	G,MG,MG,VG,F	F,MP,MG,MG,F	MG,F,VG,G,G	MP,P,MG,F,F	MG,F,VG,G,G

	C9	C10	C11	C12	C13	C14	C15
A1	F,MP,VG,MG,G	F,MP,G,MG,VG	MG,F,F,G,MG	G,MG,G,VG,F	G,MG,MG,G,G	MP,P,MG,F,MG	F,MP,G,MG,VG
A2	P,VP,F,MP,MP	MG,F,VG,G,VG	MG,F,G,G,G	G,MG,G,VG,VG	P,VP,P,MP,MP	F,MP,G,MG,F	F,MP,F,MG,F
A3	G,MG,VG,G,MP	F,MP,G,MG,G	MP,P,MP,F,G	F,MP,MG,MG,MG	MG,F,MG,G,MP	VG,G,G,G,G	MG,F,G,VG,VG
A4	MP,P,VG,G,G	G,MG,G,VG,MG	F,MP,MG,MG,MP	VG,G,F,G,F	G,MG,G,VG,MG	MG,F,MG,G,G	G,MG,G,G,VG
A5	F,MP,G,MG,G	F,MP,G,MG,MG	P,VP,F,MP,MP	MG,F,G,G,F	G,MG,MG,VG,MG	MP,P,F,F,MG	G,MG,VG,VG,G

Aggregated fuzzy decision matrix $\widetilde{D}$ is normalized based on Eq. (3) and normalized decision matrix $\tilde{R}$ is obtained. Then, weighted normalized fuzzy decision matrix $\tilde{V}$ is computed utilizing the weights obtained with F-AHP. Here, FPIS is $A^* = (v_1^*, v_2^*, v_3^*, \ldots, v_n^*)$ and FNIS is $A^- = (v_1^-, v_2^- v_3^-, \ldots, v_n^-)$, where $v_j^* = (1,1,1)$ and $v_j^- = (0,0,0)$, $j = 1,2,3,\ldots,n$, since all the criteria are benefit (maximization) criteria. Distance of each alternative from A^* (d_i^*) and from A^- (d_i^-) are calculated with the vertex method in Eq. (4) and presented in Table 5. Finally, closeness coefficient CC_i of each alternative is calculated with Eq. (5) and given in Table 5, along with the ranking of alternatives. As seen in Table 5, as a result of F-AHP-TOPSIS, alternatives are ranked from best to worst as A2 (best), A3, A1, A4, and A5.

Table 5. F-AHP-TOPSIS Results

	d_i^*	d_i^-	CC_i	Rankings
A1	6.8485	0.0267	0.0039	3
A2	6.8029	0.0326	0.0048	1 (best)
A3	6.7616	0.0320	0.0047	2
A4	6.8349	0.0229	0.0033	4
A5	6.9057	0.0201	0.0029	5

5. Conclusion

In this paper, F-AHP-TOPSIS is utilized in order to evaluate and select the best air freight specialist candidate for a global logistics company, DHL Global Forwarding. At first, importance weights of criteria are computed with F-AHP and then utilizing these weights, F-TOPSIS is implemented to rank alternative candidates. At present, there does not appear to be a research paper, that focuses on evaluation and selection of air freight specialists. Utilization of fuzzy numbers in F-AHP-TOPSIS reflects the vagueness and fuzziness on evaluations of DMs and combination of F-AHP with F-TOPSIS provides advantages of both methods.

The ranking results of F-AHP-TOPSIS are shared with the company and recommendations are made towards recruiting the best candidate, A2. In this research, "correlations between criteria" and "inner/outer dependence" and "feedback" relations between criteria are not taken into consideration. For future research, correlated F-AHP and F-ANP can be studied to overcome these aspects and these methods can be combined with F-TOPSIS for various MCDM problems.

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Acknowledgements
The authors would like to thank DHL Global Forwarding Company in Turkey for their collaboration in this research.

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