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Freight Forwarding Company Selection Using Hybrid IFAHP-IFTODIM Method

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Abstract: In selecting the best freight forwarding company, the concept of a Decision Support System (DSS) can be used to find the best solution from several alternatives. One of the DSS methods is the Intuitionistic Fuzzy Analytical Hierarchy Process (IFAHP) and Intuitionistic Fuzzy Tomada de Decisao Interativa Multicriterio (IFTODIM). This study applied the IFAHP method combined with the IFTODIM method to select the best freight forwarding company at PT Progressio Indonesia. PT Progression Indonesia is a manufacturing and retail company that produces furniture. There are 11 criteria used in the performance assessment of the four alternatives. To define the objects' ranking, we used comprehensive value. This research shows that the best freight forwarding company at PT Progressio Indonesia is Kobra Express, with a comprehensive value of 1.0000. The second is Herona Express, with a comprehensive value of 0.9436, followed by Indah Logistik Cargo, with a comprehensive value of 0.7006. The last is Guna Dharma Express, with a comprehensive value of 0.0000.

Keywords: Decision support system (DSS), IFAHP, IFTODIM.

Introduction

During various ongoing global economic challenges, Indonesia is one of the countries trying to maintain economic growth. Indonesia's economic growth was around five percent in the last five years. This growth was strongly supported by the trade sector's contribution as the second-largest contributor to Indonesia's gross domestic product after the manufacturing industry [1]. Trading activities are inseparable and depend on transportation to connect cargo, consumers, and point locations to facilitate business growth and regional prosperity. So that these economic activities run smoothly, a service agency engaged in the delivery and receipt of goods (freight forwarding) is needed. Therefore, the role of the freight forwarding company is essential.

Nowadays, there are many business actors in freight forwarding. Within this field, competition is inevitable. Similar services can confuse customers in selecting the company they prefer sending their goods. In selecting the best freight forwarding company, the Decision Support System (DSS) concept can be used to find the best solution from several alternatives. The method that can be used is the Intuitionistic Fuzzy Analytical Hierarchy Process (IFAHP) and Intuitionistic Fuzzy Tomada de Decisao Interativa Multicriterio (IFTODIM).

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IFAHP is an extension of the classical Analytical Hierarchical Process (AHP) method using the theory of Intuitionistic Fuzzy (IF). IFAHP can deal with more complex problems where decision-makers have some doubts about assigning preference values to the object being examined. In the IFAHP proposed by Xu and Liao [2], a new method is used to analyze the consistency of relationships based on intuition tendencies and automated procedures used to correct inconsistent relationships. This automated procedure can be used without the participation of a decision-maker. Thus, this procedure can save much time and is superior to AHP and FAHP.

Additionally, Tomada de Decisao Interativa Multicriterio (TODIM) is an interactive method that uses the concept of prospect theory in multi-criteria decision-making. One of the concepts in prospect theory is that individual differences in obtaining information are perceived and interpreted, which means that if two individuals are faced with the same problem, then the decisions or choices may vary. IFTODIM is a development of the classic TODIM method based on IF [3].

Several studies related to the use of the AHP methods in DSS include evaluating the quality of services provided by outsourced companies that serve organizations in the Brazilian retail sector [4], choosing project managers [5], regarding the selection of business locations [6], and guidance for managers to improve decision making and enhance performance in competitive markets [7]. The AHP method was chosen because it is one of the most inclusive systems to make decisions with multiple criteria.

Table 1. IFN scale

Preference evaluation	IFN
Extremely Important (EI) / *Extremely Good* (EG)	(0.90; 0.10; 0.00)
Very Important (VI) / *Very Good* (VG)	(0.80; 0.15; 0.05)
Important (I) / *Good* (G)	(0.70; 0.20; 0.10)
More Important (MI) / *Medium Good* (MG)	(0,60; 0,25; 0,15)
Equally Important (EqI) / *Medium* (M)	(0,50; 0,30; 0,20)
Less Important (LI) / *Medium Bad* (MB)	(0,40; 0,45; 0,15)
Unimportant (U) / *Bad* (B)	(0,30; 0,60; 0,10)
Very Unimportant (VU) / *Very Bad* (VB)	(0,20; 0,75; 0,05)
Extremely Unimportant (EU) / *Extremely Bad* (EB)	(0,10; 0,90; 0,00)

It formulates the problem as hierarchical and believes in a mixture of quantitative and qualitative criteria [8]. However, the classical AHP method's weakness is that it cannot handle fuzzy problems by decision-makers. Therefore, further research is carried out to develop AHP intoFAHP to solve fuzzy problems. Previous research regarding FAHP includes analyzing the essential factors in choosing the mode of transportation in freight forwarding [9] and evaluating the quality of international freight forwarders in the East Asia region [10]. The research is advised to be developed into IFAHP to get a deeper understanding. Previous research regarding IFAHP includes selecting the best technology and energy conservation [11], identifying and evaluating the best vendors based on several criteria [12], and analyzing the strategic service quality carried out with a digital transformation perspective in the hospitality industry [13]. Research using the TODIM method has been developed for specific elective courses by undergraduate students' abilities and interests [14]. It was argued that the classical TODIM method cannot handle fuzzy information and proposed the TODIM method based on the triangular Intuitionistic Fuzzy Number (TIFN), which is flexible in reflecting the uncertainty and doubt associated with the opinion of the decision-maker [15]. Furthermore, FTODIM was developed into IFTODIM using a trapezoidal fuzzy number [16]. From that, the hybrid method of IFAHP and TODIM was made to evaluate sustainable suppliers and conduct research on the selection of fresh agricultural products [17].

This study will select the best freight forwarding company at PT Progressio Indonesia, which is engaged in manufacturing and retail, especially furniture. In PT Progressio Indonesia, the flow of goods delivery goes through several stages, namely conducting quality control, confirming to the customer, selecting the freight forwarding company, contacting the freight forwarding company, and loading the goods. However, the selection of freight forwarding companies is made manually. Some problems often arise when choosing a freight forwarding company, includeing unresponsive companies, incomplete delivery range, expensive fees, and delivery delays because they have to wait for the cargo capacity to be packed. Those problems are the background of this research. This research applied the hybrid IFAHP and IFTODIM. The researcher chooses the methods because they can find the solution to the problem of hesitation in decision-making, obtain the weight of the criteria in a more focused, measurable, and efficient manner, and obtain the best alternative based on the principles of prospect theory. It is hoped in the future that the results of this research can determine the best freight forwarding company so that PT Progressio Indonesia and its freight. forwarding company can establish mutually beneficial cooperation.

Methods

List of Notation

λ_p	: Weight of the p-th decision maker
μ_p	: Membership degree
v_p	: Non-membership degree
π_p	: Hesitance degree
$R^{(p)}$	: Pairwise comparison matrix
$\bar{R}^{(p)}$	: IF consistency matrix
$d(\bar{R}^{(p)}, R^{(p)})$	: Consistency checker
$\tilde{R}^{(p)}$	: New IF consistency matrix
$w_i^{(p)}$	: Weight criteria of each decision maker
w_i^{merge}	: Merge weight
TV_i	: True value
w_i	: Normalized weight
$X^{(p)}$	: Decision matrix of each decision maker
X	: Group decision matrix
V	: Predominance matrix
$\delta(a_i, a_k)$	: Predominance of the evaluation object a_i relative to the evaluation object a_k
$\varphi_j(a_i, a_k)$	: The dominance of the evaluation a_i relative to the evaluation object a_k related to the index criteria c_j
w_{rj}	: Index weight relative to the reference index c_j
w^*	: $\max\{w_{cj}\}$
θ	: Attenuation coefficient in the face of loss
$d(x_{ij}, x_{kj})$	: Distance between x_{ij} and x_{kj}
T_d	: Overall performance value
$\varepsilon(a_i)$	: Comprehensive value

IFAHP and IFTODIM Methods

While classical AHP uses the Saaty scale, FAHP applies Triangular Fuzzy Number (TFN), and IFAHP employs Intuitionistic Fuzzy Number (IFN) to make pairwise comparison matrices. In IFN each member describes the membership degree, non-membership degree, and hesitance degree to represent decision makers' preferences from various aspects. The IFN scale can be seen in Table 1 [17].

In general, the IFAHP method is based on the following steps [17]:

Calculating the weight of decision-makers based on Table 1 using equation (1). Where $\sum_{p=1}^{q} \lambda_p = 1$.

$$\lambda_p = \frac{\left(\mu_p + \pi_p\left(\frac{\mu_p}{\mu_p+v_p}\right)\right)}{\sum_{p=1}^{q}\left(\mu_p + \pi_p\left(\frac{\mu_p}{\mu_p+v_p}\right)\right)} \tag{1}$$

Make a pairwise comparison matrix between criteria by each decision maker based on Table 1.

Transform pairwise comparison matrix into IF consistency matrix and checking the consistency using equation (2) as follows.

$$d\left(\bar{R}^{(p)}, R^{(p)}\right) = \frac{1}{2(n-1)(n-2)} \sum_{i=1}^{n} \sum_{j=1}^{n} \left(\left|\bar{\mu}_{ij}^{(p)} - \mu_{ij}^{(p)}\right| + \left|\bar{v}_{ij}^{(p)} - v_{ij}^{(p)}\right| + \left|\bar{\pi}_{ij}^{(p)} - \pi_{ij}^{(p)}\right|\right) \tag{2}$$

where $\bar{R}^{(p)} = \left(\bar{r}_{ij}\right)_{n\times n}$ obtained based on the equation below as follows.

If $j > i+1$, then $\bar{R}^{(p)} = \left(\bar{\mu}_{ij}, \bar{v}_{ij}\right)$

$$\bar{\mu}_{ij}^{(p)} = \frac{\sqrt[j-i-1]{\prod_{t=i+1}^{j-1} \mu_{it}^{(p)} \mu_{tj}^{(p)}}}{\sqrt[j-i-1]{\prod_{t=i+1}^{j-1} \mu_{it}^{(p)} \mu_{tj}^{(p)}} + \sqrt[j-i-1]{\prod_{t=i+1}^{j-1} (1-\mu_{it}^{(p)})(1-\mu_{tj}^{(p)})}} \tag{3}$$

$$\bar{v}_{ij}^{(p)} = \frac{\sqrt[j-i-1]{\prod_{t=i+1}^{j-1} v_{it}^{(p)} v_{tj}^{(p)}}}{\sqrt[j-i-1]{\prod_{t=i+1}^{j-1} v_{it}^{(p)} v_{tj}^{(p)}} + \sqrt[j-i-1]{\prod_{t=i+1}^{j-1} (1-v_{it}^{(p)})(1-v_{tj}^{(p)})}} \tag{4}$$

If $j = i+1$ or $j = i$, then $\bar{r}_{ij}^{(p)} = r_{ij}^{(p)}$

If $j < i$, then $\bar{r}_{ij}^{(p)} = \left(\bar{v}_{ji}^{(p)}, \bar{\mu}_{ji}^{(p)}\right)$

The IF consistency matrix is calculated based on the equation above, then substituted in equation (2) to check its consistency. If $d\left(\bar{R}^{(p)}, R^{(p)}\right) < 0{,}1$, then consistency is fulfilled. If the consistency is not satisfying, the parameter is entered into the iteration Therefore, the IF consistency matrix is transformed by adjusting the parameter until the consistency test is satisfied and the IF consistency matrix transforms to the new IF consistency matrix. The parameter $\sigma \in [0, 1]$, test the consistency using the equation (5-6)

$$\tilde{\mu}_{ij}^{(p)} = \frac{\left(\mu_{ij}^{(p)}\right)^{1-\sigma}\left(\bar{\mu}_{ij}^{(p)}\right)^{\sigma}}{\left(\mu_{ij}^{(p)}\right)^{1-\sigma}\left(\bar{\mu}_{ij}^{(p)}\right)^{\sigma} + \left(1-\mu_{ij}^{(p)}\right)^{1-\sigma}\left(1-\bar{\mu}_{ij}^{(p)}\right)^{\sigma}} \tag{5}$$

$$\tilde{v}_{ij}^{(p)} = \frac{\left(v_{ij}^{(p)}\right)^{1-\sigma}\left(\bar{v}_{ij}^{(p)}\right)^{\sigma}}{\left(v_{ij}^{(p)}\right)^{1-\sigma}\left(\bar{v}_{ij}^{(p)}\right)^{\sigma} + \left(1-v_{ij}^{(p)}\right)^{1-\sigma}\left(1-\bar{v}_{ij}^{(p)}\right)^{\sigma}}$$

$$d\left(\tilde{R}^{(p)}, R^{(p)}\right) = \frac{1}{2(n-1)(n-2)} \sum_{i=1}^{n} \sum_{j=1}^{n} \left(\left|\tilde{\mu}_{ij}^{(p)} - \mu_{ij}^{(p)}\right| + \left|\tilde{v}_{ij}^{(p)} - v_{ij}^{(p)}\right| + \left|\tilde{\pi}_{ij}^{(p)} - \pi_{ij}^{(p)}\right|\right) \tag{6}$$

Calculating the weight of the criteria of each decision maker using equation (7)

$$w_i^{(p)} = \left(\frac{\sum_{j=1}^{n} \mu_{ij}^{(p)}}{\sum_{i=1}^{n}\sum_{j=1}^{n}(1-v_{ij}^{(p)})}, 1 - \frac{\sum_{j=1}^{n}(1-v_{ij}^{(p)})}{\sum_{i=1}^{n}\sum_{j=1}^{n} \mu_{ij}^{(p)}}\right), i = 1,2,\dots,n \tag{7}$$

Merge the weight of the criteria for each decision maker using the Intuitionistic Fuzzy Weighted Averaging (IFWA) operator in equation (8)

$$w_i^{merge} = \left[1 - \prod_{p=1}^{q}\left(1-\mu_i^{(p)}\right)^{\lambda_p}, \prod_{p=1}^{q}\left(v_i^{(p)}\right)^{\lambda_p}, \prod_{p=1}^{q}\left(1-\mu_i^{(p)}\right)^{\lambda_p} - \prod_{p=1}^{q}\left(v_i^{(p)}\right)^{\lambda_p}\right] \tag{8}$$

Change the total weight that has been obtained into the true value of IFN using equation (9)

$$TV_i = \mu_i + \frac{1+\mu_i-\pi_i}{2}\pi_i \tag{9}$$

Normalize the weight of each criterion using equation (10)

$$w_i = \frac{TV_i}{\sum_{i=1}^{n} TV_i} \tag{10}$$

After getting the weight of each criterion using the IFAHP method, the IFTODIM method is used to get the best alternative. The IFTODIM method is based on the following steps [17, 18]:

Make a decision matrix $X^{(p)} = \left[x_{ij}^{(p)}\right]_{m\times n}$ from each individual decision maker. The decision matrix $X^{(p)}$ of size $m \times n$ can be written as in equation (11)

$$X^{(p)} = \begin{bmatrix} x_{11}^{(p)} & x_{12}^{(p)} & \dots & x_{1n}^{(p)} \\ x_{21}^{(p)} & x_{22}^{(p)} & \dots & x_{2n}^{(p)} \\ x_{31}^{(p)} & x_{32}^{(p)} & \dots & x_{3n}^{(p)} \\ \vdots & \vdots & \ddots & \vdots \\ x_{m1}^{(p)} & x_{m2}^{(p)} & \dots & x_{mn}^{(p)} \end{bmatrix} \tag{11}$$

where the decision matrix contains the elements $x_{ij}^{(p)} = \left(\mu_{x_{ij}}^{(p)}, v_{x_{ij}}^{(p)}\right)$, which represents the rating from the i-th alternative $(i = 1,2,\dots,m)$ against the j-th criteria $(j = 1,2,\dots,n)$.

Normalize the decision matrix. The criteria in the decision matrix are divided into two, namely benefit criteria and cost criteria. If there is a decision matrix to be normalized, then the benefit criteria and cost criteria respectively use equations (12) and (13) as follows [19]

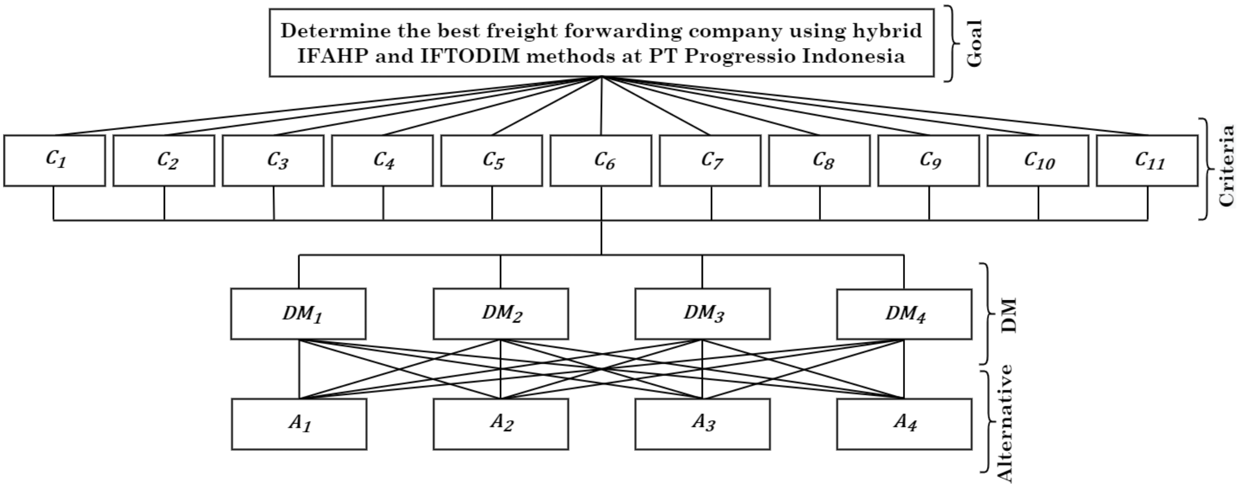

Figure 1. Hierarchical structure

$$x_{ij}^{(p)} = \left(\mu_{x_{ij}}^{(p)}, v_{x_{ij}}^{(p)}\right) \quad (12)$$

$$x_{ij}^{(p)} = \left(v_{x_{ij}}^{(p)}, \mu_{x_{ij}}^{(p)}\right) \quad (13)$$

Combine the individual decision matrix of each decision-maker into a group decision matrix using the IFWA operator as in equation (14)

$$x_{ij} = \left[1 - \prod_{p=1}^{q}\left(1 - \mu_{ij}^{(p)}\right)^{\lambda_p}, \prod_{p=1}^{q}\left(v_{ij}^{(p)}\right)^{\lambda_p}, \prod_{p=1}^{q}\left(1 - \mu_{ij}^{(p)}\right)^{\lambda_p} - \prod_{p=1}^{q}\left(v_{ij}^{(p)}\right)^{\lambda_p}\right] \quad (14)$$

Calculate the predominance matrix $V = [\ \delta(a_i, a_k)_{n\times n}]$ from the evaluation object. The calculation of $\delta(a_i, a_k)$ is given in equation (15). The predominance matrix is used to see the predominance of the evaluation object a_i relative to the evaluation object a_k

$$\delta(a_i, a_k) = \sum_{j=1}^{n} \varphi_j(a_i, a_k) \quad (15)$$

The calculation of $\varphi_j(a_i, a_k)$ is given in the equation below

If $x_{ij} - x_{kj} > 0$

$$\varphi_j(a_i, a_k) = \sqrt{\frac{w_{rj}}{\sum_{j=1}^{n} w_{rj}}} \cdot d(x_{ij}, x_{kj}) \quad (16)$$

If $x_{ij} - x_{kj} = 0$

$$\varphi_j(a_i, a_k) = 0 \quad (17)$$

If $x_{ij} - x_{kj} < 0$

$$\varphi_j(a_i, a_k) = -\frac{1}{\theta}\sqrt{\frac{\sum_{j=1}^{n} w_{rj}}{w_{rj}}} \cdot d(x_{ij}, x_{kj}) \quad (18)$$

where $w_{rj} = \left(\frac{w_{cj}}{w^*}\right)$ and $0 < \theta < \left(\frac{\sum_{j=1}^{n} w_{rj}}{w_{rj}}\right)$ is generally 2.25. Furthermore, the distance between x_{ij} and x_{kj} which can be calculated using Euclidean distance as in equation (19) as follows [20]

$$d(x_{ij}, x_{kj}) = \sqrt{\frac{1}{2}\sum_{i,k=1}^{n}\left[\left(\mu_{x_{ij}} - \mu_{x_{kj}}\right)^2 + \left(v_{x_{ij}} - v_{x_{kj}}\right)^2 + \left(\pi_{x_{ij}} - \pi_{x_{kj}}\right)^2\right]} \quad (19)$$

Calculate the overall performance is given in equation (20) as follows

$$T_d = \sum_{k=1}^{m} \delta(a_i, a_k) \quad (20)$$

Calculate the evaluation object's comprehensive value using equation (21) as follows. The comprehensive value is the final score that is used to determine the ranking of the objects. The evaluation objects are sorted according to the size of the comprehensive value. The greater the value of a comprehensive object, the better the evaluation object.

$$\varepsilon(a_i) = \frac{T_d - \min\{T_d\}}{\max\{T_d\} - \min\{T_d\}} \quad (21)$$

Results and Discussions

This study uses primary data obtained through interviews with PT Progressio Indonesia to determine criteria, alternatives, and decision-makers. After that, the decision-makers fill out questionnaires, and the results are used to obtain the criteria weights and alternative performance scores on each criterion. The criteria used in this study refer to the research by Huang *et al.* [10], and there are several differences, namely the absence of the criteria for consult service and regular visits and the addition of insurance criteria. This study used 11 criteria: instant response (C_1), cheaper agency fee (C_2), global serviceability (C_3), tailor-made service (C_4), door-to-door ability (C_5), schedule reliability (C_6), excellent reputation (C_7), stable space supply (C_8), fast document handling (C_9), instant cargo tracking (C_{10}), and insurance (C_{11}).

Table 2. Weight of decision-maker

Decision maker	λ_i (weight)
DM_1	0.2854
DM_2	0.2636
DM_3	0.2392
DM_4	0.2118

Table 3. Consistency check of the IF matix $\bar{R}^{(p)}$

Matrix	$d(\bar{R}^{(p)}, R^{(p)})$
$\bar{R}^{(1)}$	0.1855
$\bar{R}^{(2)}$	0.2350
$\bar{R}^{(3)}$	0.2314
$\bar{R}^{(4)}$	0.2093

Table 4. Consistency check of the new IF matix $\tilde{R}^{(p)}$

Matrix	$d(\tilde{R}^{(p)}, \bar{R}^{(p)})$
$\tilde{R}^{(1)}$	0.0316
$\tilde{R}^{(2)}$	0.0390
$\tilde{R}^{(3)}$	0.0390
$\tilde{R}^{(4)}$	0.0350

The alternative is a freight forwarding company which often delivers goods to customers in PT Progressio Indonesia. Four alternatives are assessed for their performance. The first one is Indah Logistik Cargo (A_1) which specializes in shipping goods throughout Indonesia. The second one is Kobra Express (A_2) which provides customs affairs, imports of goods, documents, and national and international delivery. Then the Herona Express (A_3) which is one of the railroad freight forwarding companies engaged in shipping services via trains and truck boxes to more than 50 cities on Java, Bali and Madura. The fourth is Guna Dharma Express (A_4), a reliable provider of goods delivery services by many garment companies, food manufacturers, herbs, printing, textiles, yarn, machine parts, document delivery and other commodity goods.

Based on the interviews with the project manager, there are four parties involved in the decision-making to choose the freight forwarding company to deliver goods to customers, namely the project manager (DM_1), operational division (DM_2), finance division (DM_3), and marketing division (DM_4). The hierarchical structure model is presented in Figure 1.

The first step is to calculate the weight of the decision-maker by changing the level of linguistic importance to the IFN scale based on Table 1. Furthermore, by using Equation (1), the weights for each decision-maker can be obtained which can be seen in Table 2.

Table 2 shows that the decision-maker with the highest weight is the project manager, operational division, finance division, and marketing division. After the decision-makers' weight was computed, we make a matrix of pairwise comparison $(R^{(p)})$ from each decision-maker. Then, each matrix $R^{(p)}$ is transformed into an IF consistency matrix $(\bar{R}^{(p)})$. The consistency value of the IF matrix $\bar{R}^{(p)}$ is calculated using Equation (2), and the consistency of the IF matrix $\bar{R}^{(p)}$ can be seen in Table 3. In Table 3, it can be seen that all values of $d(\bar{R}^{(p)}, R^{(p)}) > 0.1$, which means that they do not meet the consistency of the IF matrix $\bar{R}^{(p)}$. Therefore, a new IF consistency matrix $(\tilde{R}^{(p)})$ must be created, which is obtained from the results of transforming the IF matrix $\bar{R}^{(p)}$ using equation (5). Furthermore, the new IF matrix $\tilde{R}^{(p)}$ is checked for consistency using equation (6), and the consistency value of the new IF matrix $\tilde{R}^{(p)}$ can be seen in Table 4.

In Table 4 all the values of $d(\tilde{R}^{(p)}, \bar{R}^{(p)}) < 0.1$, which means that the consistency test of the IF matrix $\tilde{R}^{(p)}$ has been met. The next step is to calculate the weight of the criteria for each decision-maker $\left(w_i^{(p)}\right)$. The value of $w_i^{(p)}$ can be calculated using Equation (7). The weight of each criterion obtained from each decision-maker is then calculated using Equation (8). After that, change the value of w_i^{merge} to true value (TV) using Equation (9). The last step is to normalize the value of TV using Equation (10) which then can be used as the weight of the criteria in the IFTODIM method.

Based on Table 5, it can be seen that the criterion with the highest value of weight is the cheaper agency fee, followed by global service ability, and instant response. It shows that low prices of services are the most important criteria for decision-makers to choose the best freight forwarding company.

IFTODIM method is used to get alternative performance values. The first step that must be done is to make a decision matrix ($X^{(p)}$) by each decision maker. After that, the linguistic importance of the $X^{(p)}$ matrix is converted into an IFN scale based on Table 1. The next step is to combine the $X^{(p)}$ matrix into a group decision matrix (X) using Equation (14). After the X matrix is formed, create a predominance matrix (V) using Equation (15) which follows the provisions in Equation (16)-(18). Next, we calculate the overall performance of the alternative (T_d) based on equation (20) and then we calculate the comprehensive alternative value $(\varepsilon(a_i))$ based on Equation (21).

In Table 7, we have the alternative A_2 is more dominance comparing to alternative A_1 and A_4, and it is less dominance than A_3 (since the score is negative). The total dominancy of A_2 is positive because the gain of the A_2 is more than its loss respectively [3] and the comprehensive value is 1.0000. Then the alternative who has the least total dominancy score is A4 and the comprehensive value is 0.0000.

Table 5. Normalized criterion weight

i	w_i^1	w_i^2	w_i^3	w_i^4	w_i^{merge}	TV	w_i
1	(0.0818; 0.8204)	(0.0854; 0.8138)	(0.0836; 0.8136)	(0.0835; 0.8169)	(0.0835; 0.8163)	0.1328	0.1220
2	(0.0873; 0.8186)	(0.0879; 0.8171)	(0.0814; 0.8192)	(0.0941; 0.8147)	(0.0875; 0.8175)	0.1346	0.1237
3	(0.0842; 0.8248)	(0.0767; 0.8301)	(0.0840; 0.8207)	(0.0655; 0.8497)	(0.0782; 0.8304)	0.1233	0.1133
4	(0.0608; 0.8539)	(0.0718; 0.8424)	(0.0694; 0.8434)	(0.0702; 0.8424)	(0.0678; 0.8459)	0.1101	0.1012
5	(0.0748; 0.8370)	(0.0641; 0.8595)	(0.0596; 0.8570)	(0.0710; 0.8411)	(0.0675; 0.8485)	0.1088	0.1000
6	(0.0648; 0.8531)	(0.0561; 0.8619)	(0.0556; 0.8536)	(0.0665; 0.8507)	(0.0607; 0.8550)	0.1018	0.0936
7	(0.0437; 0.8838)	(0.0557; 0.8589)	(0.0551; 0.8559)	(0.0506; 0.8734)	(0.0510; 0.8683)	0.0902	0.0829
8	(0.0389; 0.8938)	(0.0411; 0.8832)	(0.0481; 0.8683)	(0.0404; 0.8927)	(0.0420; 0.8846)	0.0775	0.0712
9	(0.0453; 0.8803)	(0.0345; 0.8975)	(0.0358; 0.8937)	(0.0314; 0.9087)	(0.0373; 0.8940)	0.0706	0.0648
10	(0.0380; 0.8888)	(0.0318; 0.8997)	(0.0324; 0.8974)	(0.0421; 0.8797)	(0.0359; 0.8918)	0.0708	0.0650
11	(0.0289; 0.9033)	(0.0377; 0.8801)	(0.0287; 0.8990)	(0.0341; 0.8905)	(0.0323; 0.8934)	0.0679	0.0624

Table 6. Decision matrix

	DM_1				DM_2				DM_3				DM_4			
	A_1	A_2	A_3	A_4	A_1	A_2	A_3	A_4	A_1	A_2	A_3	A_4	A_1	A_2	A_3	A_4
C_1	G	M	G	VG	G	G	G	G	G	G	G	VG	G	MB	M	VG
C_2	M	VG	G	G	M	G	M	G	M	G	G	G	MB	G	G	VG
C_3	VG	M	MG	G	G	MB	M	M	G	M	G	G	M	B	M	M
C_4	G	MG	MG	G	G	M	G	G	G	G	G	VG	M	MB	M	G
C_5	VG	G	M	G	G	M	G	G	G	G	G	G	G	M	G	VG
C_6	G	G	G	G	G	G	G	G	VG	M	G	G	MG	M	G	G
C_7	VG	G	G	MG	G	G	G	G	G	G	G	VG	VG	M	MG	G
C_8	MG	G	VG	MG	M	G	M	G	M	G	G	G	M	G	G	G
C_9	G	G	G	G	M	G	G	G	G	G	G	G	G	G	G	G
C_{10}	M	MG	MG	MG	G	G	G	G	G	G	G	G	VG	MB	G	VG
C_{11}	M	M	G	MG	M	M	M	M	G	G	G	G	M	MB	MG	MG

VG= Very Good, G=Good, M = Medium, MG = Medium Good, MB = Medium Bad, B = Bad (see Table 1)

Table 7. Predominance matrix

Alternative	A_1	A_2	A_3	A_4	T_d	$\varepsilon(a_i)$	Rank
A_1	-	-1.0168	-0.8383	0.3492	-1.5058	0.7006	3
A_2	0.2077	-	-0.0309	0.5456	0.7224	1.0000	1
A_3	0.1619	-0.3573	-	0.4979	0.3025	0.9436	2
A_4	-1.7007	-2.6367	-2.3822	-	-6.7195	0.0000	4

Table 8. Comprehensive alternative scores under different attenuation coefficients

Alternative	$\theta = 0.1$	$\theta = 1$	$\theta = 2$	$\theta = 2.25$	$\theta = 3$	$\theta = 4$	$\theta = 10$
A_1	0.7333	0.7187	0.7040	0.7006	0.6908	0.6787	0.6245
A_2	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
A_3	0.9555	0.9502	0.9448	0.9436	0.9400	0.9356	0.9158
A_4	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

Additionally, Table 7 also shows that the best freight forwarding company at PT Progressio Indonesia is Kobra Express. The second is Herona Express, followed by Indah Logistik Cargo. The last is Guna Dharma Express.

After getting the best freight forwarding company, sensitivity analysis can be carried out to verify whether there are differences in the results of selecting the best freight forwarding company with different values of θ (representing different psychological abilities or behavior of decision-makers in avoiding risk). In this study, six values of θ (0.1, 1, 2, 3, 4, 10) [17,21] were used for sensitivity analysis.

As shown in Table 8, when the value of θ increased, the comprehensive values of A_1 and A_3 decreased. It shows the decision maker's ability to avoid risk becomes weaker, resulting in more errors in the assessment of freight forwarding companies. The value of means decision makers focuses more on the risk-seeking rather than negative impact caused by losses. Based on Table 8, it can be seen that with six different theta values, the results of selecting the right forwarding company tend to be consistent. It is obvious that the rank results are not sensitive to different values.

Conclusion

Many studies have examined the selection of the best freight forwarding company. However, the traditional decision support system methods such as AHP and ANP were still employed to determine the weight of the criteria, although they are not accurate in handling information uncertainty due to the lack of expert knowledge or decision-makers. Nevertheless, the intuitionistic fuzzy AHP method can handle the fuzziness problem and convert fuzzy information into accurate numbers. Furthermore, when ranking freight forwarding companies, the alternative ranking methods such as TOPSIS, WASPAS, and MOORA do not consider the decision maker's subjective preference behavior, which often loses much qualitative information. On the other hand, the intuitionistic fuzzy TODIM method considers the decision maker's psychological behavior, which can deal with environmental uncertainty and ensure that the original information is not distorted.

Therefore, IFAHP and IFTODIM were employed to select the best freight forwarding company. In order to verify the feasibility of the proposed integration method, an example of sensitivity analysis was carried out. The final calculation results indicated that IFAHP and IFTODIM were feasible and effective in selecting the freight forwarding company. Moreover, the indicators that influence the quality improvement of the freight forwarding company were obtained. Finally, further research is necessary since the current model is relatively subjective in determining the weight of each indicator using the model. Due to the lack of research in this field, the current evaluation index system may not be universally applied. Future research also needs to consider the customer/consignee as a decision-maker because the personal relationship between customer and freight forwarding company may be a significant factor to determine the quality of the freight forwarding company.

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