FUZZYTOPSIS Method in Selection of Seventh Party Logistics

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***Abstract*:-** Selection and assessment of a seventh-party logistics (7PL) that combines a company's global operations is the focus of this article. The selection process is determined by the criteria and the fuzzy triangular numbers assigned to each one. When dealing with complicated issues involving multi-criteria decision making, the FTOPSIS is employed. A modern approach combines a fuzzy decision making trial, evaluation and fuzzy techniques to order preferences by similarity to ideal solution (FTOPSIS) methods. Choosing a transportation provider is one of the most important choices for a successful business. Final selection is carried out following the criteria's identification using FTOPSIS. Researchers can use this publication as a resource to better understand and apply FTOPSIS to MCDM difficulties.

Keywords: *FTOPSIS Method, Criteria, Seventh-Party Logistics, Outsourcing and Logistics Companies.*

I Introduction

Many companies are now providing a range of services in light of the expanding trend of logistics outsourcing. The primary focus of these services is business-to-business connections that are impacted by the provider's service quality, who are also important stakeholders. As a result, the user must specify exactly what it requires from the supplier. In addition, a number of are examined for a provider in relation to logistics outsourcing. It is not simple to choose a suitable supplier that meets the requirements of the outsourcing organization. There is a finite amount of possibilities available for multiple-criteria evaluations due to the way the problem-solving process is organized. The possibilities in multiple criteria design problems, often known as multiple objective mathematical programming problems [1], are not well defined. A mathematical model can be solved to find an alternative (solution). When multiple variables are continuous, the number of possibilities is either not countable or infinite; if countable, there are usually many alternatives (when all variables are discrete). However, it is thought that both types of problems fall under the category of MCMD problem [2]. MCDM is the process of making judgments when confronted with several, often contradictory criteria. Each distinct criterion may have a unique unit of measurement, corresponding weight, and quality feature. While some criteria can only be defined subjectively, others may be quantifiable in numerical form. Multiple-criteria decision analysis (MCDA) or multiple-criteria decision making (MCDM) is a sub-category of operations research that explicitly considers many criteria in decision-making. When numerous variables are involved, it's imperative to thoroughly arrange the issue and objectively evaluate each one. It is necessary to openly consider a range of elements and thoroughly structure difficult challenges in order to make better informed decisions [3-5].

II FTOPSIS Method

When ranking one or more options according to several criteria out of a set of feasible alternatives, multiple criteria decision makingis frequently employed. Linguistic assessments, or the assessment of the weightages and rankings of the problem's criteria by linguistic factors, can be utilized as a more practical substitute for numerical values. Language-specific terms, such as high, medium, low, etc., are regarded as typical examples of judgmental representations. These characteristics demonstrate that the structure of decision makers' preferences can be captured by fuzzy set theory. The degree of ambiguity in notions related to human subjective judgments can be measured using the fuzzy set theory. Furthermore, the evaluation process in group decision-making should be conducted in an ambiguous and unclear setting, as it is influenced by the perspectives of different evaluators on linguistic characteristics. We suggest fuzzy TOPSIS a new method for integrating using subjective and objective weights in order to systematically evaluate alternatives under different criteria, which is inspired by MCDM. Only the decision makers' subjective weights are taken into account by most MCDM techniques [6-8]. On the other hand, user attitude may play a significant role. We suggest a unique strategy that includes the end user throughout the entire decision-making process. The subjective weights that DM (decision makers) assign are normalized into a comparable scale in this suggested method. Furthermore, we use user ratings as an impartial weight. A closeness coefficient is defined to determine the ranking order of alternatives by calculating the distances to both ideal and negative-ideal solutions. Many implementations exist in which fuzzy TOPSIS is deployed in MADM [9].Because precise data regarding decision makers' assessments is not available; most requirements that must be completed in MADM cannot be perfectly assessed.

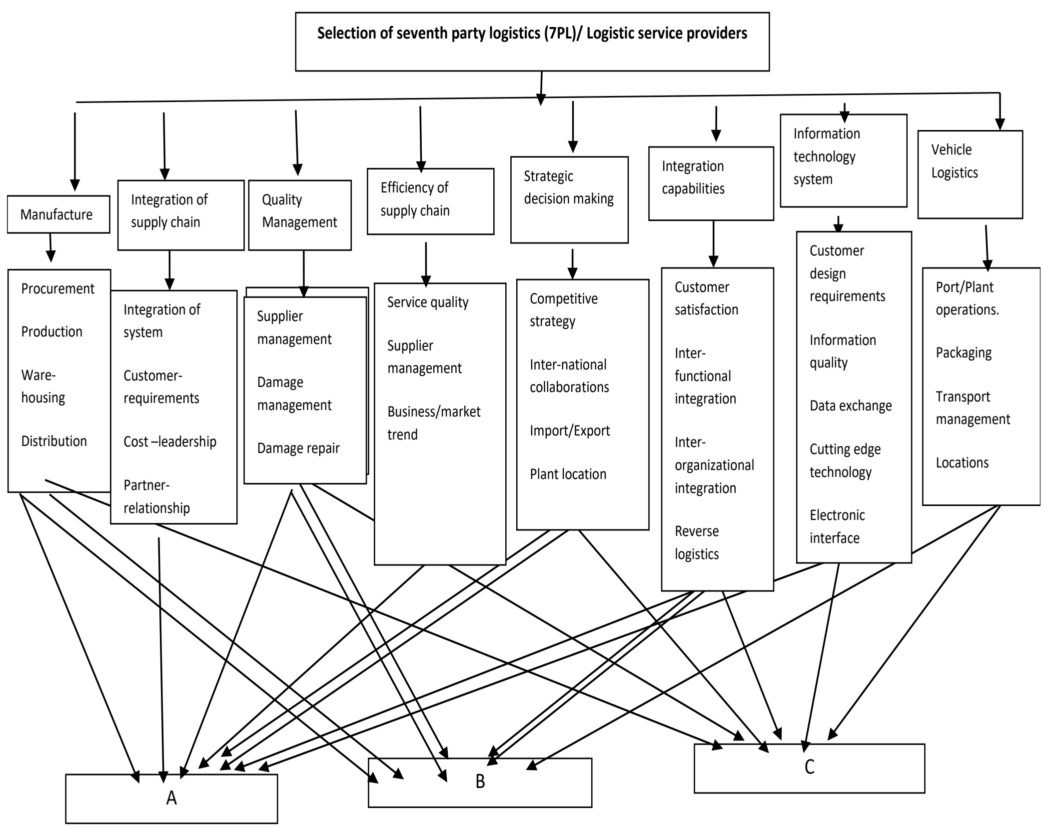

Figure 1.1 Structure of a Seventh Party Logistics Service Provider

III Steps in FTOPSIS

The fuzzy MCDM approach can be used to synthesize the rating of alternatives and ascertain the significance of weights for assessment objectives. After that, a final decision is made by applying the TOPSIS method to get a clear potential performance value for each alternative [10-11].

Steps of Fuzzy TOPSIS [12-13]:

First, matrix of dimension $m \times n$for decision (D) is defined as in

$$D_{ij} = \begin{bmatrix} x_{11} & x_{12} & x_{13} & \cdots & \cdots & x_{1n} \\ x_{21} & x_{22} & x_{23} & \cdots & \cdots & x_{2n} \\ x_{31} & x_{32} & x_{33} & \cdots & \cdots & x_{3n} \\ \vdots & \vdots & \vdots & \vdots & \vdots & \vdots \\ \vdots & \vdots & \vdots & \vdots & \vdots & \vdots \\ x_{m1} & x_{m2} & x_{m3} & \cdots & \cdots & x_{mn} \end{bmatrix} \ldots\ldots\ldots(1)$$

$$\tilde{w} = \widetilde{w_1}, \widetilde{w_2}, \ldots \ldots \ldots \ldots .. \widetilde{w_n}$$

Step 1: the decision matrix is Normalized for fuzzy, $\tilde{R}$:

$\tilde{R}$= $[r_{ij}]_{mxn}$,i=1,2,…….m ; j= 1,2,………n. …………..(2)

The direct criteria, the normalized value $\widetilde{r_{ij}}$,is calculated as: $\tilde{r}_{ij} = \left(\frac{l_{ij}}{u_j^+}, \frac{m_{ij}}{u_j^+}, \frac{u_{ij}}{u_j^+}\right)$; $where;\ u_j^+ max_i u_{ij}$…………..(3)

And the indirect criteria, normalized value $\widetilde{r_{ij}}$,is calculated as: $\tilde{r}_{ij} = \left(\frac{l_j^-}{u_{ij}}, \frac{l_j^-}{m_{ij}}, \frac{l_j^-}{l_{ij}}\right)$; $where;\ l_j^- = min_i l_{ij}$…………(4)

Step 2: Calculate the weighted normalized fuzzy decision matrix. The weighted normalized value V_{ij}calculated by$V_{ij} = [\tilde{v}_{ij}]_{mxn}$,i = 1,2,….m, and j= 1,2,……n,…………..(5)

$\tilde{v}_{ij} = \tilde{r}_{ij} \times \tilde{w}_j$ i = 1,2,….m, and j= 1,2,……n ;…………..(6)

where$\tilde{v}_{ij}$ is the fuzzy weight of j^{th} criterion.

Step 3: Identify positive idea solution (PIS),(A^+),and negative ideal solution (NIS),(A^-)solutions. $V_j^+$and V_j^-may be obtained through some ranking procedures.The$V_j^+$and V_j^- are the fuzzy numbers with the largest and the smallest generalized mean, respectively. The generalized mean for fuzzy numberV_{ij}, i$\forall j$, is defined as

$$A^+ = \{\tilde{v}_\iota, \tilde{v}_{2,\ldots\ldots\ldots\ldots} \widetilde{v_n^+}\}, \ldots\ldots\ldots\ldots\ldots..(7)$$

j *is associated with the positive criteria*

and

$$A^- = \{\tilde{v}_\iota, \tilde{v}_{2,\ldots\ldots\ldots\ldots} \widetilde{v_n^-}\} ,\ldots\ldots\ldots\ldots\ldots(8)$$

jisassociatedwiththenegativecriteria

Step4. Calculate the distance of each alternative from S_i^+ and S_i^- . For fuzzy data, the difference between two fuzzy numbers is explained as given in

$$S_i^+ = \sqrt{\sum_{j=1}^{n}\left(v_j^+ - v_{ij}\right)}^2 , i = 1,2, \ldots \ldots m \ , \ldots\ldots\ldots\ldots(9)$$

$$and S_i^- = \sqrt{\sum_{j=1}^{n}\left(v_j^+ - v_{ij}\right)}^2 , i = 1,2, \ldots \ldots m, \ldots\ldots\ldots\ldots(10)$$

Step5. Compute the relative closeness to ideals. This index is used to combine S_j^+ and S_j^- indices calculated in Step4. Since S_j^+ and S_j^- are crisp numbers, they can be combined

$$CC_i^- = \frac{s_j^+}{s_j^-} \ ; \ i = 1,2, \ldots . n, \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots(11)$$

Step 6. Rank preference order. Choose an alternative with maximum CC_i^+ or rank alternatives according to CC_i^-in descending order.

The linguistic variables are used in the decision-making process to establish the significance of the goal weights for the logistic service provider criteria. With the aid of the linguistic variables indicated in table 1 and in accordance with the decision criteria as delineated in table 3.7 the decision makers evaluated the alternatives.

Table 1 Linguistic Variables Used in the Assessment of Alternatives

S.No.	Linguistic Variable	Triangular Fuzzy Number
1	Very POOR(VP)	(0,0,1)
2	Poor(P)	(0,1,3)
3	Medium POOR(MP)	(1,3,5)
4	Fair(F)	(3,5,7)
5	Medium GOOD(MG)	(5,7,9)
6	Good(G)	(7,9,10)
7	Very GOOD(VG)	(9,1,1)

The linguistic variables are used in the decision-making process to establish the significance of the goal weights for the logistic service provider criteria. With the aid of the linguistic variables indicated in table 1 and in accordance with the decision criteria as delineated in table 2 the decision makers evaluated the alternatives.

Table 2 Assessment Results of Alternatives in Line with the Criteria's

S.No.	Decision makers	LSP/ Criteria	MANU	ISC	QMT	ESC	SDM	IC	ITS	VL
1	DM 1	A	G	MG	F	G	G	G	G	P
		B	MG	G	MG	G	G	MG	MG	P
		C	G	MG	G	MG	G	G	VG	P
2	DM 2	A	G	MG	F	VG	P	G	VG	MP
		B	MG	G	MG	G	VG	P	F	P
		C	G	MG	G	F	G	F	MG	MG
3	DM 3	A	G	MG	G	MG	MG	MG	MP	MP
		B	MG	G	MG	MG	F	MG	P	MP
		C	MG	MG	VG	G	VG	G	P	MG

A normalized fuzzy decision matrix was created using the triangular fuzzy numbers that were acquired from the evaluation of the linguistic factors. Step 2's help was then utilized to normalize the matrix. The weighted normalized matrix is calculated by multiplying the weights by the normalized decision matrix. Find the separation measure values for each logistic service provider for the optimal result. The ranking of the preference order Ri is based on how close it is to the optimal solution. A high C* value for the proximity coefficient indicates that the best alternative among the three logistics service provider.After converting the linguistic variables assessments into triangular fuzzy numbers we have table 3.

Table 3 AlternativesAssessment Results as Fuzzy Numbers.

Decision makers	LSP/ Criteria's	MANU	ISC	QMT	ESC	SDM	IC	ITS	VL
DM 1	A	7,9,10	5,7,9	3,5,7	7,9,10	7,9,10	7,9,10	7,9,10	0,1,3
	B	5,7,9	7,9,10	5,7,9	7,9,10	7,9,10	5,7,9	5,7,9	0,1,3
	C	7,9,10	5,7,9	7,9,10	5,7,9	7,9,10	7,9,10	9,10,10	9,10,10
DM 2	A	9,10,10	79,10	9,10,10	0,1,3	9,10,10	9,10,10	9,10,10	1,3,5
	B	7,9,10	7,9,10	7,9,10	9,10,10	0,1,3	0,1,3	3,5,7	0,1,3
	C	7,9,10	1,3,5	3,5,7	7,9,10	3,5,7	3,5,7	5,7,9	5,7,9
DM 3	A	7,9,10	5,7,9	7,9,10	5,7,9	5,7,9	5,7,9	1,3,5	1,3,5
	B	5,7,9	7,9,10	5,7,9	5,7,9	5,7,9	3,5,7	1,3,5	1,3,5
	C	5,7,9	5,7,9	9,10,10	7,9,10	7,9,10	9,10,10	1,3,5	5,7,9

The fuzzy decision matrix shown in table 4 was normalized with help step2 and a normalized fuzzy decision matrix was obtained as shown in table 5.

Table 4 Fuzzy Decision Matrix

LSP/ Criteria's	MANU	ISC	QMT	ESC	SDM	IC	ITS	VL
A	5,8.33,10	5,7.66,10	3,7,10	5,8.33,10	7,9,10	5,8.33,10	5,8.66	0,1,3
B	7,9.33,10	1,7,10	3,8,10	0,6.66,10	0,5.33,10	0,5.33,10	3.733	0,3.33,9
C	5,7.66,10	5,7.66,10	5,8.66,10	5,8.66,10	5,7.66,10	3,7.33,10	1,3,5	1,4.33,9

Table 5 Normalized Decision Matrix

Weight	5,7,9	3,5,7	1,3,5	5,7,9,	7,9,9	7,9,9	5,7,9	1,3,5
LSP/ Criteria's	MANU	ISC	QMT	ESC	SDM	IC	ITS	VL
A	0.5,0.833 ,1	5,7.66,10	0.3,0.7,1	0.5,0.833, 1	0.7,0.9,1	0.5,0.86 61	0.5,0.86 6,1	0,0.33,1
B	0.7,0.93, 1	0.1,0.7,1	0.3,0.8,1	0,0.666,1	0,5.33,10	0,0.533, 10	0.3,0.73 3,1	0,037,1
C	0.1,0.13, 0.2	0.1,0.130, 0.2	0.1,0.115, 0.2	0.1,0.115, 0.2	0.1,0.136,0 .33	0.2,0.33 ,1	0.2,0.33 3,1	0.111,0.23 1,1

Weighted normalized matrix is calculated by multiplying the weights with normalized decision matrix as shown in the table 6.

Table 6 Weighted Normalized Decision Matrix

Calculate the separation measure values for each logistic service provider for the positive ideal and negative ideal solutions values as shown in table 7.

LSP/ Criteria's	MANU	ISC	QMT	ESC	SDM	IC	ITS	VL
A	2.5,5.83,9	1.5,3.83, 7	0.3,2.1,5	2.5,5.83, 9	4.9,8.1,9	3.5,7.49, 9	2.5,6.062, 9	0,0.99,5
B	3.5,6.53,9	0.3,3.5,7	0.3,2.4,5	0,4.66,9	0,4.979, 9	0,4.797, 9	1.5,5.131, 9	0.111,0.69, 5
C	0.5,0.91, 1.8	0.3,0.65, 1.4	0.1,0.345, 1	0.5,0.80 5, 1.8	0.7,0.80 5, 1.8	0.7,1.22 4, 2.997	1,2.331,9	0,1.111,5

Table 7 Seperation Measures

LSP/criteria	FPIS (S_i^+)	FNIS(S_i^-)
A	1.64165556	68.1792194
B	13.3436005	72.0687957
C	63.402797	0.43538718

The relative closeness to the ideal solution and rank the preference order R_i. A large value of closeness coefficient C^* indicates a good performance of the alternative A_i as shown in table 8.

Table 8 Closeness Cofficient

LSP/criteria	C*= Closeness coefficient	Rank (R_i)
A	0.976487611	1st
B	0.843774427	2nd

C	0.006820169	3rd

IV Results

During the assessment process, the triangular fuzzy numbers were utilized by the decision makers. After the method's application steps were finished, logistic service provider A was chosen since, based on the specified criteria, its closeness coefficient value was found to be the highest. This selection was therefore considered to give the company a competitive advantage as well as effective management. This study demonstrates how decision makers can rank their alternative logistic service provider by using the fuzzy TOPSIS method.

TABLE 9 Ranking of the logistic service provider

S.No.	LSP/criteria	C*= Closeness coefficient	Rank (R_i)
1	A	0.976487611	1st rank
2	B	0.843774427	2nd rank
3	C	0.006820169	3rd rank

Therefore, from final value table 9, LSP 'A' shows the highest value of **0.976487.** So LSP 'A' is better than the other two LSP's 'B' and' C'. LSP 'A' is chosen as the best 7PL service provider under FTOPSIS Method. According to the results obtained by FTOPSIS method, LSP 'A' **(logistic service provider-A**) is favored over other LSP's (B and C) with highest score **0.976487**. This superiority of the first LSP with respect to LSP's 'B' and' C' can be explained by considering (goal) criteria values.

V Conculsions

Selection of logistics service providers is a challenging task, as the management needs to be fully aware about the service providers and their qualities. MCDM techniques FTOPSIS uses linguistic variable scale for converting rating into the fuzzy numbers, later recognizes the criteria that effects the selection of the LSP. Most influencing Criteria-Manufacturing (MANU) with higher positive ideal solution value 1.220, followed by criteria –Quality Management with higher positive ideal solution value 0.300 and followed by criteria – Vehicle Logistics with higher positive ideal solution value 0.121.

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