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A COMPARATIVE ANALYSIS OF SEVENTH PARTY LOGISTICS SERVICE PROVIDER USING HYBRID MODELS: AHP- ELECTRE, AHP-TOPSIS AND AHP-PROMETHEE

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ABSTRACT:

Businesses, particularly those who are in the manufacturing sectors, prefer to concentrate on their core competencies. As a result, they must choose process to outsource their logistics Seventh-Party Logistics Service Providers (7LPs). Therefore, the assessment and choice of a seventh-party logistics service provider capable of efficiently offering logistics operation services to the companies is the most crucial strategic concern for top management. Using both qualitative and quantitative data, decision-making models assist decision-makers in setting future goals. This research paper's primary goal is to develop a decision-supporting tool that will assist the management of the organization in selecting and evaluating different seventh-party logistics service providers through a hybrid approach that incorporates the Analytical Hierarchy Process (AHP) along with other MCDM methods like ELECTRE, TOPSIS and PROMEHTHEE. The current study compares three models and provides a general knowledge of MCMD. In this study, the weights of the criterion have been estimated using the AHP approach after the selection criteria of 7PL providers have been established. Later, the MCDM techniques like ELECTRE, TOPSIS and PROMETHEE are used to arrive at the ultimate ranking outcomes. This study offers decision makers a rigorous and scientific decision support system that is helpful for making complex and strategic decisions. There is also a numerical example provided.

Keywords: *Criteria, AHP, ELECTRE, TOPSIS, PROMETHEE,, Logistics Companies, Logistics operations Logistics Service Providers and Seventh Party Logistics.*

I INTRODUCTION

Many firms have refocused their operations around their core capabilities as a result of globalization, contracting for services that are no longer essential to their processes and are no longer intended to be completely handled by third parties. The 1990s saw a huge expansion of logistics outsourcing services as a result of this movement. Outsourcing logistics may lower asset investments, improve operational flexibility, and free up more time for the company's core activities in addition to cutting costs and enhancing service quality. Consequently, logistics providers have been faced with increasingly complex and varied logistic requirements, as illustrated in [1]. In this competitive environment with limited financial resources, many manufacturers have realized that the logistics sector is not where their core capabilities lay. A single logistics service provider offers 4PL and 3PL services to a customer. The turnkey solution known as seventh-party logistics, or 7PL, allows customers to work with a single individual under the "one contract, one bill" concept as opposed to many individuals for various logistical services like warehousing, outbound, and inbound. Combining the well-known 3PL sector with the 4PL concept—which was initially created and branded by Accenture - is the simple idea that forms the basis of 7PL. The following is the format for the remainder of this paper. Multi-criteria decision-making (MCDM) techniques are a group of techniques intended to make sure that an amalgamation of information from various sources is recorded and focused on a specific objective. They can aid in the comparison of options using decision matrices [1, 2]. During the past few decades, MCDM has been used incredibly. Solving real-world issues with many, contradictory, and incommensurate qualities is a common application of MCDM [3, 4]. MCDM is specifically effective in a wide range of selection procedures [5]. The purpose of this paper is to showcase the most popular MCDM techniques rather than examine each one in detail. Using the databases Elsevier, Springer, Science Direct, and IEEE Explore, to locate those approaches using keywords, abstract, and title were used to search for popular MCDM techniques [6]. Three methods of MCDM were found: Analytic Hierarchy Process (AHP) [7], Technique for Order of Preference by Similarity to Ideal Solution (TOPSIS) [8], Elimination Et Choix Traduisant la REality (ELECTRE) [9], and Preference Ranking Organization Method for Enrichment Evaluation (PROMETHEE) [10]. It was clear from the literature research that the selection process could be represented as an MCDM problem. When choosing from predefined choice alternatives, selection problems may involve a number of distinct and conflicting criteria [11]. The present study helps in selection and evaluation through the hybrid models like AHP-ELECTRE, AHP-TOPSIS and AHP-PROMETHEE methods are Multi-Criteria Decision Making Methods (MCDM) used to select and evaluate the Seventh Party Logistics service Providers.

2 LITERATURE REVIEW

The well-known multi-criteria decision-making methods AHP (Saaty 1980) and ELECTRE (Roy 1968) are used extensively in many different sectors. AHP has become a key MCDA strategy. It leverages individuals' skills to find pertinent answers to problems. A one-dimensional scale of precedence is created by combining multi-dimensional scales of measurement through the adhesion of AHP. It can also represent the stake holder's preference and is frequently employed as an outranking method across a range of industries. The priority is also represented by this approach. Outranking comparisons to reduce decision-makers' bias in comparisons with criteria [12]. When the choices are displayed in odd scales, the ELECTRE-I approach can

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be used. The ability to handle data in a variety of measuring scales, both quantitative and qualitative, is ELECTRE's most significant feature. According to Samaras et al. [13], ELECTRE's strength is found in both its mathematical soundness and adaptability. Thus, by establishing relationships with the appropriate dimensions and connecting potential paths with the appropriate barriers through a decision-making matrix, the advantages of the AHP and ELECTRE approaches may be combined to provide an efficient decision support tool for evaluating GSCM hurdles. The research framework that has been designed will encourage practitioners to engage with a new area of study. Additionally, it will help stakeholders and decision-makers find new obstacles to the implementation of LSP's. The hybrid AHP-ELECTRE framework that has been designed will also help decision-makers select barriers that work. The study's findings will also encourage policymakers to support the LSP in industry.

AHP and TOPSIS were selected due to the fact that AHP is one of the most widely used MCDM techniques and offers numerous benefits. [14]: recognition of the hierarchical structure, AHP is scalable and may readily adapt in size to meet decision-making challenges. TOPSIS is a method for locating the alternative that is most similar to the ideal solution and most dissimilar from the negative perfect solution in a multi-dimensional computing space [15], but it also offers a number of advantages, as an easy process. It's simple to program and operate. The following factors have led to TOPSIS and AHP becoming a commonly used integrated multi-criteria decision analysis method: having the capacity to offer comprehensive ranking results; being appropriate for integration with stochastic analysis; the smoothing of traders by handling nonlinear relationships, the use of objective data and weights to compute the euclidean distances, and how easily it can be transformed into a programmed process. Our research's main objective is to offer a practical tool for decision-making so that a model may be developed that takes into account the choices and judgments of the decision makers (DMs). According to Tavana and Hatami-Marbini [16], the choice of an MCDM framework or method should be carefully considered in light of the problem's nature, choice types, measurement scales, attribute dependencies, uncertainty types, DM expectations, and the quantity and quality of the available data and judgments. In the current paper, an AHP-TOPSIS hybrid model is used for the aforementioned reasons. There are numerous factors, strategies, and tactics involved in choosing an effective Logistics Service Provider. A methodical approach must be created for determining and ranking pertinent criteria as well as assessing the trade-offs between them (Zhang et al., 2004) [17]. In order to tackle the aforementioned issue, an integrated method of the analytical hierarchy process. For enrichment evaluation, the AHP and the preferable ranking organization approach (PROMETHEE) have been proposed in this work. The hybrid AHP-PROMETHEE variant is the only one in used exclusively in this study of the Logistics Service Provider selection procedure, adding a completely fresh perspective to the crucial managerial choice.

ISSN: 2178-7727

3 METHODOLOGIES

3.1 A Hybrid MCDM Technique by Using Different Combinations of MADM Methods:

Multiple attribute decision-making (MADM), a subfield of multiple criteria decision making (MCDM), is designed to help decision makers make decisions when they have to make many, conflicting judgments. To choose and evaluate possible solutions for a multi-criteria problem, MADM is utilized. Saaty [7] created the AHP, a multi-criteria decision-making technique, in 1980. It is a multi-objective analytical approach that uses a ratio scale to quantitatively examine qualitative events.

The AHP method's capacity to deconstruct the choice problem using a tree structure is one of its main advantages. A better overall comprehension of the problem is made possible for the decision-maker by breaking down the choice problem into its component pieces, or criteria, which can then be further broken down into smaller elements, or sub-criteria.

STEPS USED IN HYBRID MODEL:

AHP- Model STEPS which are common for all MCDM methods

STEP 1: To establish the problem and gather criteria, and collect data (ratings).

STEP 2: The criteria weights are established by building pair-wise comparison matrices. To create a decision hierarchy pair-wise comparison matrix, the geometric mean of the values derived from the individual assessments is calculated. The comparison matrix is used to calculate the criterion weights.AHP model, Steps 1 and 2 are common for all the hybrid models, later the second MCDM models like ELECTRE, TOPSIS and PROMETHEE are implemented to find the results.

CASE 1: AHP-ELECTRE

Step 3: The Conformity (C) and Nonconformity (D), Concordance and Discordance matrix, Conformity Supremacy matrix (F), and Nonconformity Supremacy matrix (G) are all determined using ELECTRE computations in the third stage.

Step 4: To establish the rank, find the matrix (E) for the Total Dominance values and determine the decision values' relative relevance.

CASE 2: AHP- TOPSIS

Step 3: Determine the decision matrix that has been normalized.

Step 4: Execute the normalized weighted decision matrix.

Step 5: Find the optimal solution in terms of positive and negative ideal solutions.

Stepn6: Determine each logistic service provider's separation measure values based on the optimal solution.

Step 7: Determine how close the logistics service provider is to the positive ideal solution, then rank them according to the high value of the positive ideal solution.

CASE 3: AHP-PROMETHEE

Step 3: The logistic service providers' priority weights are established in the third stage using PROMETHEE calculations. The parameters and preference functions are established first.
Step 4: For partial ranking, PROMETHEE I will be utilized, and for complete ranking, PROMETHEE II.

3.2 Selection of Criteria suitable for the Logistics Service Provider

Selecting the appropriate logistics service provider is a crucial choice for every company that contracts out its logistical needs. It is necessary to take into account certain facts in order to identify the best service. Evaluation criteria for logistic service providers should include performance, knowledge and skills, infrastructure and experience, price and delivery, track record, service, flexibility to meet the needs of the company, picking and packing, finance and payment management, invoice and order tracking, and more. on the 7PL services, a set of criteria and sub-criteria are gathered from a variety of sources, including web pages, purchase staff, logisticians, transporters, managers of different firms, and others.

The list is given to companies that use logistic service providers based on their skills, experience, and other factors to see if the criteria are appropriate for 7PL. 18 criteria were discovered in the primary list, and a combined table displaying the organizations' preferred criteria provided to establish 8 criteria for assessing the logistic service providers. Also 40 sub-criteria discovered from the primary list, and a combined table displaying the organizations' preferred identified for assessing the logistic service providers. A recent development in LSP assessment is the use of hybrid MCDM approaches, which integrate or combine two approaches for the MCDM problem selection and evaluation. The so-called hybrid MCDM approaches, which combine two or more separate approaches to exploit the benefits and suppress the drawbacks of each, depending on the problem being solved, have grown in popularity since the turn of the twenty-first century and particularly in recent years.

3.3Implementation of the Hybrid Models

The hybrid models chosen for this study are AHP-ELECTRE, AHP-TOPSIS, and AHP-PROMETHEE. The creation of individual or hybrid approaches in the context of intuitive or interval sets that are more suited to the characteristics of human (decision maker) thought and evaluation is a new subfield in MCDM. Examples of environments where the MCDM approach has been developed include fuzzy sets, grey sets, rough sets, etc.

The main methodology for applying the Hybrid MCDM method consists of three basic steps:

a) Choosing the sets of alternative LSP's and criteria (or sub-criteria) for evaluation.

b) Establishing the weights of the criteria and sub-criteria by giving them numerical values.

ISSN: 2178-7727

c) Assigning numerical values to the alternative LSP's in accordance with the criteria based on AHP as first MCDM Method in hybrid model.

d) Evaluation of the alternative LSP's using the second method of MCDM like ELECTRE, TOPSIS and PROMETHEE which enable ranking and choosing the best alternative as a part of hybrid model.

3.4 Mathematical Approach for Hybrid model

3.4.1 AHP Approach:

AHP was created to address intricate MCDM issues with several qualitative and quantitative factors. Using a 1–9 scale, it enables decision makers to express their preferences (Saaty, 1980, 1994). When a group of experts or an individual is trying to make a judgment, this scale can be quite helpful. AHP's function is to assign weights to each criteria and option. Three steps are needed for AHP:

(1) Creating a hierarchy of evaluation criteria;

(2) Evaluating decision maker assessments through pair-wise comparisons; and

(3) Determining weights for criteria and alternatives using the eigenvector approach.

By assessing the reliability of the pair-wise comparison procedure derived from decision makers' preferences, AHP also takes logical consistency into account. According to Saaty [7], Chan et al.[18], Isnıklar and Bu¨yu¨ko¨zkan [19 and 20] , O¨ nu¨ t and Soner [21], and Wu et al. [22], the AHP technique comprises the following steps.

A) Establish matrix of pair wise comparison using a relative importance scale.

Create a decision matrix for pair-wise comparisons (A). Let a_{ij} be a quantified assessment of a pair of components C_i, C_j, and let $C_1, C_2, \ldots, C_n$ be the set of elements. A measurement scale with the following values is used to rate the relative importance of two elements: 1 means "equally important," 3 means "slightly more important," 5 means "strongly more important," 7 means "demonstrably more important," and 9 means "absolutely more important." Also, as a compromise between the aforementioned values, 2, 4, 6, and 8 are employed. This results in the following n-by-n comparison matrix A:

B) Normalizing weight (w_i) of each criterion

Create 'M' matrix as the pair-wise comparison of criteria 'i' with criteria 'j' gives a new matrix $A_{1\,(m \times m)}$

where, a_{ij} denotes the relative importance of the criteria 'i' with respect to criteria 'j'

In the matrix, $a_{ij} = 1$ when $i=j$ and $a_{ij} = 1/a_{ij}$. ,when $i \neq j$.

$$GM_i = \left(\pi_{j=1}^{M} a_{ij}\right)^{1/M} \quad \ldots\ldots.. \quad (3.1)$$

and $$W_i = GM_i / \sum_{j=1}^{M} GM_i \quad \ldots\ldots\ldots.. \quad (3.2)$$

ISSN: 2178-7727

C) To find A3 and A4 the matrices as follows:

$$A_3 = A_1 * A_2, \quad \ldots\ldots\ldots\ldots\ldots (3.3)$$

$$A_4 = A3/A_2 \quad \ldots\ldots\ldots\ldots\ldots (3.4)$$

where, $A_2 = [w_1, w_2, \ldots\ldots, w_j]^T$ ………………(3.5)

D) Calculate the maximum eigen value from matrix A_4,which is the mean

E) Compute the CI as consistency index.

F) Compute the CR as consistency ratio.

3.4.2 ELECTRE Approach:

Steps in ELECTRE Method

Step 1: A matrix (A) representing the decision making model is formed by the stake holders

$$A_{ij} = \begin{bmatrix} a_{11} & a_{12} & a_{13} & \cdots & \cdots & a_{1n} \\ a_{21} & a_{22} & a_{23} & \cdots & \cdots & a_{2n} \\ a_{31} & a_{32} & a_{33} & \cdots & \cdots & a_{3n} \\ \vdots & \vdots & \vdots & \vdots & \vdots & \vdots \\ \vdots & \vdots & \vdots & \vdots & \vdots & \vdots \\ a_{m1} & a_{m2} & a_{m3} & \cdots & \cdots & a_{mn} \end{bmatrix} \quad \ldots\ldots\ldots\ldots (4.1)$$

Step2: Expression for normalized decision matrix , X_{ij}

$$X_{ij} = \frac{Aij}{\sqrt{\sum_{k=1}^{m} A_{kj}^2}} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (.4.2)$$

Where, 'k' is the alternatives.

$$\text{Resultant Matrix}, \quad X_{ij} = \begin{bmatrix} x_{11} & x_{12} & x_{13} & \cdots & \cdots & x_{1n} \\ x_{21} & x_{22} & x_{23} & \cdots & \cdots & x_{2n} \\ x_{31} & x_{32} & x_{33} & \cdots & \cdots & x_{3n} \\ \vdots & \vdots & \vdots & \vdots & \vdots & \vdots \\ \vdots & \vdots & \vdots & \vdots & \vdots & \vdots \\ x_{m1} & x_{m2} & x_{m3} & \cdots & \cdots & x_{mn} \end{bmatrix} \ldots\ldots\ldots\ldots (.4.3)$$

Step 3: Expression for weighted normalized decision matrix, Y_{ij}

$$Y_{ij} = \begin{bmatrix} w_1x_{11} & w_2x_{12} & \cdots & \cdots & w_nx_{1n} \\ w_1x_{21} & w_2x_{22} & \cdots & \cdots & w_nx_{2n} \\ w_1x_{31} & w_2x_{32} & \cdots & \cdots & w_nx_{3n} \\ \vdots & \vdots & \vdots & \vdots & \vdots \\ \vdots & \vdots & \vdots & \vdots & \vdots \\ w_1x_{m1} & w_2x_{m2} & \cdots & \cdots & w_nx_{mn} \end{bmatrix} \ldots\ldots\ldots\ldots\ldots\ldots (4.4)$$

w = priority weightage values for the criteria given

Step 4: Calculating the values for Conformity (C_{kl}) and Nonconformity (D_{kl}) grids

$$C_{kl} = j,\ y_{kj} \geq y_{ij} \ldots\ldots\ldots\ldots\ldots (4.5)$$

$$D_{kl} = j,\ y_{kj} \leq y_{ij} \ldots\ldots\ldots\ldots\ldots\ldots (4..6)$$

Step 5: Expression for Conformity (C) and Nonconformity (D)given in the form of matrices

$$\text{C Matrix is given as, } c_{kl} = \sum_{j \in c_{kl}} w_j; \ldots\ldots\ldots\ldots\ldots\ldots\ldots(4.7)$$

$$\text{D Matrix is given as, } d_{kl} = \frac{max|y_{kj}-y_{ij}|j \in D_w}{max|ykj-yij|} \ldots\ldots\ldots\ldots(4.8)$$

Matrix D is also $m * m$ and it cannot take value for k = l. The matrix D is calculated using the above formula and is shown below:

$$D_{ij} = \begin{bmatrix} - & d_{12} & d_{13} & \cdots & \cdots & d_{1n} \\ d_{21} & - & d_{23} & \cdots & \cdots & d_{2n} \\ d_{31} & d_{32} & - & \cdots & \cdots & d_{3n} \\ \vdots & \vdots & \vdots & \vdots & \vdots & \vdots \\ \vdots & \vdots & \vdots & \vdots & \vdots & \vdots \\ d_{m1} & d_{m2} & d_{m3} & \cdots & \cdots & - \end{bmatrix} \ldots\ldots\ldots\ldots(4.9)$$

Step 6: Expression for F matrixfor Conformity Supremacy and G matrix for Nonconformity Supremacy by the formula given below:

$$\text{If } c_{kl} \geq \underline{c} \rightarrow f_{kl} = 1 \text{ , and if } c_{kl} \leq \underline{c} \rightarrow f_{kl} = 0 \text{ .}$$

$$\underline{c} = \frac{1}{m(m-1)} \sum_{k=1}^{m} \sum_{l=1}^{m} c_{kl} \ldots\ldots\ldots\ldots(4.10)$$

$$\text{If } d_{kl} \geq \underline{d} \rightarrow g_{kl} = 1\text{, and if } d_{kl} \leq \underline{d} \rightarrow g_{kl} = 0.$$

$$\underline{d} = \frac{1}{m(m-1)} \sum_{k=1}^{m} \sum_{l=1}^{m} d_{kl} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots(4.11)$$

Step 7: Expression for E matrix for finding the Total Dominance values

$$E = f_{kl} \times g_{kl} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots(4.12)$$

Step 8: Determining the Order of importance for the Decision values.

The conformance supremacy and nonconformity supremacy matrices are computed using threshold values of c-bar and d-bar. The "f_{lk}" Conformity Supremacy and "g_{lk}" Nonconformity Supremacy matrices should be located in order to ascertain the order of importance. The matrix for aggregate dominance is then determined. The matrix E , aggregate dominance is the result of multiplying the "F" and "G" matrices. After getting the aggregate dominance matrix, the ELECTRE method's last step is to rank the decision points according to relevance.

3.4.3 TOPSIS Approach:

TOPSIS procedure can be determined by the following steps:

Step 1: Formulate the decision matrix and calculate the normalized decision matrix 'r_{ij}' valueas

$$r_{ij} = \frac{f_{ij}}{\sqrt{\sum_{j=1}^{J} f_{ij}^2}} \quad , j=1,23\ldots\ldots J; \quad i = 1,2,3\ldots\ldots n \quad \ldots\ldots\ldots\ldots(5.1)$$

Step 2: Find the normalized weighted decision matrix values as v_{ij}

$$v_{ij} = w_i^{*} r_{ij} \quad , j=1,2,3,,,,,,,J \;, i = 1,2,3.....,n \quad \ldots\ldots\ldots\ldots(5.2)$$

where w_i, , the weight of the i^{th}attribute or criterion, and $\sum_{i=1}^{n} w_i=1$.

Step 3: Compute both the ideal solutions positive and negative.

$$A^{*} = \{v_1^{*},\ldots\ldots\ldots, v_n^{*}\} = \{(max \quad {}_j v_{ij} | i\epsilon I^{I}),\ (\min j\, v_{ij} | i\epsilon I^{II})\ \} \ldots\ldots\ldots(5.3)$$

$$A^{-} = \{v_1^{-},\ldots\ldots\ldots, v_n^{-}\} = \{(min \quad {}_j v_{ij} | i\epsilon I^{I}),\ (\max j\, v_{ij} | i\epsilon I^{II})\ \} \ldots\ldots\ldots(5.4)$$

where I^{I} is associated with most criteria , and I^{II} is associated with least criteria.

Step 4: Find the metrics separation values using the ideal solutions, both positive and negative.

$$D_j^{*} = \sqrt{\sum_{i=1}^{n} (v_{ij} - v_i^{*})}^{2} , \quad j = 1,2,3\ldots\ldots J\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots(5.5)$$

$$D_j^{-} = \sqrt{\sum_{i=1}^{n} (v_{ij} - v_i^{-})}^{2} , \quad j = 1,2,3\ldots\ldots J\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots(5.5)$$

Step 5: Determine the relative proximity coefficient to the positive ideal solution. The definition of the alternative a_j relative proximity to **Cj*** is

$$C_j^{*} = \left(\frac{D_j^{-}}{D_j^{*}+D_j^{-}}\right), j = 1,2,3\ldots\ldots\ldots\ldots J\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots(5.6)$$

Step 6: Select the option that is closest to 1 or rank the preferences in order. The relative proximity coefficient values are arranged in descending order. The logistic service providers are rated based on how close their relative proximity coefficient value is to one.

3.4.4 PROMETHEE Approach:

PROMETHEE I Method

Step 1: Using the matrix as decision data and rating for each criteria formulate a decision matrix. The importance of each criteria varies from the others, which influences the outcome.

Step 2: Execute the equations to normalize the evaluation matrix (decision matrix).

$$R_{ij} = \frac{[x_{ij-\min(x_{ij})}]}{[\max(x_{ij}) - \min(x_{ij})]} , R_{ij} for beneficial criteria \ldots\ldots\ldots. (6.1)$$

where $i=1,2,3\ldots m$ and $j=1,2,3\ldots..n$

$$and R_{ij} = \frac{[\max(x_{ij}) - x_{ij}]}{[\max(x_{ij}) - \min(x_{ij})]} , R_{ij} for non - beneficial criteria \ldots\ldots (6.2)$$

where $i=1,2,3\ldots m$ and $j=1,2,3\ldots..n$

Step 3: Find the preference function Pj (a,b) by computing the evaluation difference of the i^{th} choice relative to the other alternatives.

$P_j(a,b) = 0 \quad if R_{aj} \leq R_{bj} and \ P_j(a,b) = R_{aj} - R_{bj} if R_{aj} > R_{bj}$……………..(6.3)

Step 4: Calculate the total preference π(a,b) as shown.

$$\pi(a\ ,b) = \frac{[\sum_{j=1}^{n} w_j p_j(a\ ,b)]}{\sum_{j=1}^{n} w_j} \text{……………….(8.4)}$$

Step 5: Apply the following formulas to find the values of the entering flow (+) and the departing flow (-) as indicated:

$$\emptyset^+ = \frac{1}{m-1}\sum_{b=1}^{m} \pi(a\ ,b)\, when(a \neq b) and \emptyset^- = \frac{1}{m-1}\sum_{b=1}^{m} \pi(b\ ,a)\, when(a \neq b) \quad \text{….(6.5)}$$

$where m = number of alternatives.$

Step 6:Determine the net outranking values for the entering flow ($ø^+$) and the departing flow ($ø^-$).

$$\emptyset \ \ (a) = \emptyset^+ (a) - \emptyset^- (a) \text{ ………………… (6.6)}$$

Step 7: Ranking every alternative that is taken into consideration based on the values of $\emptyset \ \ (a)$. Logistic service provider will be chosen from the highest values of$\emptyset \ \ (a)$.

4 Evaluation Using Hybrid Models

4.1 AHP-ELECTRE

Step wise implementation of the AHP-ELECTRE technique

Table 4.1 CRITERIA'S WEIGHTAGE VALUES ASSIGNED TAKEN BY DECISION-MAKING COMPANIES

S.No.	Criteria's	Weights	Weightages Value
1	Manufacturing(Manu)	w_1	0.35
2	Integration of Supply Chain (ISM)	w_2	0.21
3	Quality Management(QM)	w_3	0.14
4	Efficiency of Supply Chain (ESM)	w_4	0.11
5	Strategic Decision Making (SDM)	w_5	0.07
6	Integration Capabilities (IC)	w_6	0.04
7	Information Technology (IT)	w_7	0.03
8	Vehicle logistics (VL)	w_8	0.02

Table 4.2 DECISION MATRIX

S. No.	**Weights**	**0.35**	**0.21**	**0.14**	**0.11**	**0.07**	**0.04**	**0.03**	**0.02**
	LSP↓ /Criteria' →	MANU	ISC	QMT	ESC	SDM	IC	ITS	VL
1	LSP A	0.33	0.37	0.36	0.36	0.37	0.37	0.35	0.35
2	LSP B	0.34	0.32	0.29	0.34	0.31	0.28	0.30	0.32
3	LSP C	0.32	0.31	0.31	0.35	0.30	0.31	0.33	0.32

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Table 4.3 NORMALIZED WEIGHTED DECISION MATRIX

S. No.	Weights	0.35	0.21	0.14	0.11	0.07	0.04	0.03	0.02
	LSP↓ /Criteria's →	Manu	ISC	QMT	ESC	SDM	IC	ITS	VL
1	LSP A	0.1999	0.1342	0.0869	0.0677	0.0451	0.0260	0.0183	0.0121
2	LSP B	0.212	0.1160	0.0700	0.0658	0.0378	0.0240	0.0162	0.0111
3	LSP C	0.1938	0.1124	0.0845	0.0564	0.0378	0.0225	0.0173	0.0114

Table 4.4 CONCORDANCE MATRIX

S. No.	LSP	CONCORDANCE MATRIX			
		A	B	C	
1	A	0	0.42686	0.99685	
2	B	0.3567	0	0.67986	
3	C	0	0.31699	0	
	Total of each column	0.3567	0.74385	1.67671	2.77726
		CBAR	0.462876667		

Table 4.5 DISCONCORDANCE MATRIX

S. No.	LSP	A	B	C	
1	A	0	0.815121	1	
2	B	1	0	0.174439	
3	C	1	1	0	
	Total of each column	2	1.815121	1.174439	4.98956
		DBAR	0.831593324		

Table 4.6Concordance Dominance Matrix

S. No.	LSP	A	B	C
1	A	0	0	1
2	B	0	0	1
3	C	0	0	0

Table 4.7Dis-concordance Dominance Matrix

S. No.	LSP	A	B	C
1	A	0	0	1
2	B	1	0	0
3	C	1	1	0

Table 4.8 Total Dominance Matrix

S. No.	LSP	A	B	C	Order of importance

1	A	0	0	1	1
2	B	0	0	0	0
3	C	0	0	0	0

Table 4.9 Order of Importance and Ranking

LSP	Order of importance	Ranking
A	**1**	**1st place**
B	0	2nd place
C	0	2nd place

In this hybrid method LSP ‘A’ is better ranked than LSP ‘B’ and LSP ‘C’.

4.2 AHP-TOPSIS

Step wise implementation of AHP-TOPSIS technique, table 4.1 to 4.3 are common steps for this method as AHP. Later TOPSIS method will be carried out to find the best alternative LSP.

Table 4.10 Positive Ideal and Negative Ideal Solutions

S. No.			MANU	ISC	QM	ESC	SDM	IC	ITS	VL
	1	**Positive Ideal Solution**	0.075	0.05072	0.03322	0.02476	0.01862	0.0103	0.00654	0.00348
	2	**Negative Ideal Solution**	0.06317	0.0367	0.02167	0.01692	0.01329	0.00627	0.00484	0.00299

Table 4.11Separation Measures Values

S. No.	LSP	S*	S^-
1	A	0.006512334	0.02200733
2	B	0.019542465	0.013362134
3	C	0.02128889	0.010335676

Table 4.12 Relative Closeness and Ranking

S. No.	LSP	RELATIVE CLOSENESS	RANKING
		*C1**	R_i
1	A	0.771654611	1st
2	B	0.406087127	2nd
3	C	0.326824272	3rd

When compared to LSPs "B" and "C," LSP A is the best in this hybrid model.

ISSN: 2178-7727

4.3 AHP-PROMETHEE

AHP-PROMETHEE methodology step-by-step implementation: Tables 4.1 to 4.3 are typical steps for this method as AHP. To determine the optimal alternative LSP, the PROMETHEE approach will be used later.

Table4.13 Preference P_j (a,b)

Weights	0.35967	0.21326	0.14845	0.10999	0.07883	0.04353	0.02967	0.01656
Preferences	MANU	ISC	QM	ESC	SDM	IC	ITS	VL
P(A-B)	0	0.95353	0	0	0	0	0	0
P(A-C)	0	0	0	0	0	0	0	0
P(B-A)	1.11679	0.95353	1	0.2444	1	1	1	1
P(B-C)	0	0	0.83835	0	0.04196	0.61993	0.49095	0.22835
P(C-A)	1	1	0.16164	1	0.958	0.38	0.509	0.7716
P(C-B)	0	0.04647	0	0.75556	0	0	0	0

Table 4.14 Aggregate Preference, Π(a,b)

Weights	0.35967	0.21326	0.14845	0.10999	0.07883	0.04353	0.02967	0.01656
Preferences	MANU	ISC	QM	ESC	SDM	IC	ITS	VL
Wj * P(A-B)	0	0.20335	0	0	0	0	0	0
Wj *P(A-C)	0	0	0	0	0	0	0	0
Wj *P(B-A)	0.40168	0.20335	0.14845	0.02688	0.07883	0.04353	0.02967	0.01656
Wj *P(B-C)	0	0	0.12445	0	0.00331	0.02699	0.01457	0.00378
Wj *P(C-A)	0.35967	0.21326	0.024	0.10999	0.07552	0.01654	0.0151	0.01278
Wj *P(C-B)	0	0.00991	0	0.0831	0	0	0	0

Table 4.15 Net Flow Outranking Values

LSP	**$ø^+$(leaving flow)**	**$ø^-$(entering flow)**	**ø(a)**	Ranking
A	0.07783	0.5919	0.51407	1st rank
B	0.37401	0.10883	-0.26518	2nd rank
C	0.30662	0.05769	-0.24893	3rd rank

LSP ‘A’ has a higher rating of 0.51407, making it the best logistics provider in this hybrid model.

5 Results and Discussion

To combine the advantages of both MCDM methods, the study also aims to describe hybrid multi-criteria decision making techniques, including the Integration of Analytical Hierarchy Process with Technique for Order Preference by Similarity to Ideal Solution (AHP-TOPSIS), the Integration of Analytical Hierarchy Process with Preference Ranking Organization Method of Enrichment Evaluation (AHP-PROMETHEE), and the Integration of Analytical Hierarchy Process with Elimination and Choice Translating Reality (AHP-ELECTRE). The following are the ultimate findings from the hybrid analysis of multiple models.

As indicated in the table 4.9, LSP A USING AHP-ELECTRE yields Final Values of 2 following the determination of the aggregate dominance matrix. LSP "A" is obviously superior to the others. LSP "A" is therefore selected over LSPs "B" and "C." This research led to the conclusion that, when compared to LSPs B and C, LSP-A's aggregate dominance value was the highest by far.

LSP "A" displays the highest closeness value of 0.771654 according to final valuetable 4.12 . Thus, LSP "A" is superior to LSPs "B" and "C." Using the AHP-TOPSIS Method, LSP "A" is selected as the top 7PL service provider. With a highest score of 0.771654, LSP "A" is preferred over LSP's B and C, per the results. By taking criterion values into account, it is possible to explain why the first LSP is superior to LSPs "B" and "C." The Topsis approach uses the Euclidean distance principle to determine the ideal positive value that is highest for the criterion among all other criteria. As a result, it scores higher than LSPs "B" and "C."

By using the PROMETHEE method, **ø (a)** are obtained as shown in table 4.15for the three of the LSP's on the re-sources of eight criteria. According to these results, LSP-A emerged as a best with a highest value of **0.514** which offers the most suitable logistic conditions, while the second and the third place belong to LSP-B and LSP-C, respectively.

6 Conclusions

Among the hybrid MCDM approaches for evaluating Logistic Service Providers, the AHP-PROMETHEE model emerges as the most effective and robust. This model combines the structured weight derivation from the Analytic Hierarchy Process (AHP) with the nuanced, the ability to rank based on preferences of PROMETHEE. Unlike AHP-TOPSIS, which offers simplicity but lacks the ability to model preference thresholds, or AHP-ELECTRE, which can result in partial rankings and complex interpretations, AHP-PROMETHEE provides a complete and flexible ranking system. It accommodates both qualitative and quantitative criteria, supports sensitivity analysis, and allows decision-makers to incorporate real-world judgment through preference functions and thresholds. These features make AHP-PROMETHEE particularly suitable for complex logistics environments where trade-offs between cost, service quality, flexibility, and reliability must be carefully evaluated. As a result, it offers a more realistic and comprehensive decision support tool for selecting the most appropriate Logistic Service Provider. For evaluating Logistic Service Providers in a real-world, multi-criteria environment that involves subjective preferences, thresholds, and the need for robust sensitivity analysis, the AHP-PROMETHEE model stands out as the most effective and decision-maker-friendly hybrid MCDM approach.

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