

Selection of Seventh Party Logistics Using PROMETHEE Method

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Abstract: *In this study, shippers assisted in the initial identification of the criteria for choosing integrated service providers and the development of an integrated model based on their interrelationship. To fulfill the needs of the client, the users are moving more and more toward managing their entire supply chain operations through seventh party logistics (7PL) service providers. With this understanding of the elements to take into account and how they relate to one another when choosing an integrated service provider. Subsequently, the PROMETHEE METHOD priority weights were used to choose 7PL service providers. For many businesses, 7PL service providers have been a source of competitive advantage.*

Keywords: Seventh-Party Logistics, PROMETHEE Method, Criteria, And Logistics Companies

1. Introduction

Business organizations are being forced to invest in and pay attention to their entire supply chain as a result of the fierce competition in today's global markets, the introduction of products with shorter life cycles, the faster dissemination and proliferation of information, and the higher expectations of customers. The idea behind 7PL is as straightforward as combining the well-known 3PL industry with Accenture's initially developed and trademarked 4PL concept. Professor Jean-Pierre Brans [1] invented PROMETHEE in 1982. Only the fundamental PROMETHEE I and II rankings were included at the time. Shortly afterward, Bertrand Mareschal and Jean-Pierre Brans began collaborating on the method's development. In 1983, PROMETHEE IV (continuous) and III (interval order) extensions were suggested. The first computer program on a mainframe was implemented at that time.

The process is a multi-criteria decision support system that enables the construction of an outranking between various options. For MCDA problems where the decision maker specifies the indifference and preference thresholds but not the weights of the criteria, this work employs the criterion with linear preference and indifference area of PROMETHEE. A linear programming is constructed to infer the weights of criteria that are consisting of the decision maker's preferences through the preference relation of some pairs of alternatives. Finally, the PROMETHEE II method can be used to rank the alternatives according to net flow, going from best to worst. This technique lessens the impact of subjective factors on decision-making because the criteria's weights are not predetermined. This method avoids the situation where a small difference on some criterion [2] can cause a large difference in evaluations of the alternatives by taking the indifference and preference threshold into account.

2. Steps in Promethee

2.1 PROMETHEE - I Ranking

The PROMETHEE approach compares each alternative pair to each of the chosen criteria in a reciprocal manner. After defining the criteria, preference function $P(a, b)$ for alternatives a and b must be defined in order to perform alternative ranking using the PROMETHEE method. The criteria functions are used to evaluate options a and b . If $f(a) > f(b)$, then alternative a is deemed superior to alternative b based on criterion f , if $f(a) > f(b)$. Based on this kind of comparison, the decision maker can choose which of the alternatives to prioritize [3, 4]. The preference can have values between 0 (zero) and 1 (one), and the following relations can be used to represent possible relation combinations:

$P(a, b) = 0$ indicates no preferences, apathy,

One strong preference $k(a) \gg k(b)$, one strict preference $k(a) \gg \gg k(b)$, and $P(a, b) = 0$ weak preference $k(a) > k(b)$ are the possible outcomes.

The following are the limitations of relations:

$$0 < P(a,b) > 1, \quad (1)$$

$$P(a,b) \neq P(b, a) \quad (2)$$

A higher value from the specified interval indicates a higher preference. This indicates that the decision-maker takes into account a particular preference function for each criterion [Nikolić 5]. Once the kind of general criterion has been established, After specifying the kind of general criterion, it is required to compute the index of preferences (IP) of action a with respect to action b and ascertain the value of function preference of action a with regard to action b for each criterion. Set A consists of every pair of actions. The following formula is used to determine the index preference:

The formula for

$$IP(a, b) = \sum_j^n W_j P_j(a, b), \quad \sum W_j = 1 \quad (3)$$

where b is the weight of criterion "j" and W_j is its value.

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IP (a,b)=(1/n) is the preferred index if all criteria have the same weight,

$$\text{or if } IP(a,b) = \left(\frac{1}{n}\right) \cdot \sum_j^n P_j(a,b), \quad (4)$$

which is established by the subsequent relation:

$$0 \leq P_j(a,b) \leq 1 \text{ for all } 0 \text{ values.} \quad (5)$$

The alternative fault index T (a), whose value indicates the relevance of the alternative, can finally be calculated after calculating index preference IP (a,b). The ultimate determination of an alternative's sufficiency among the group of alternatives is based on this index.

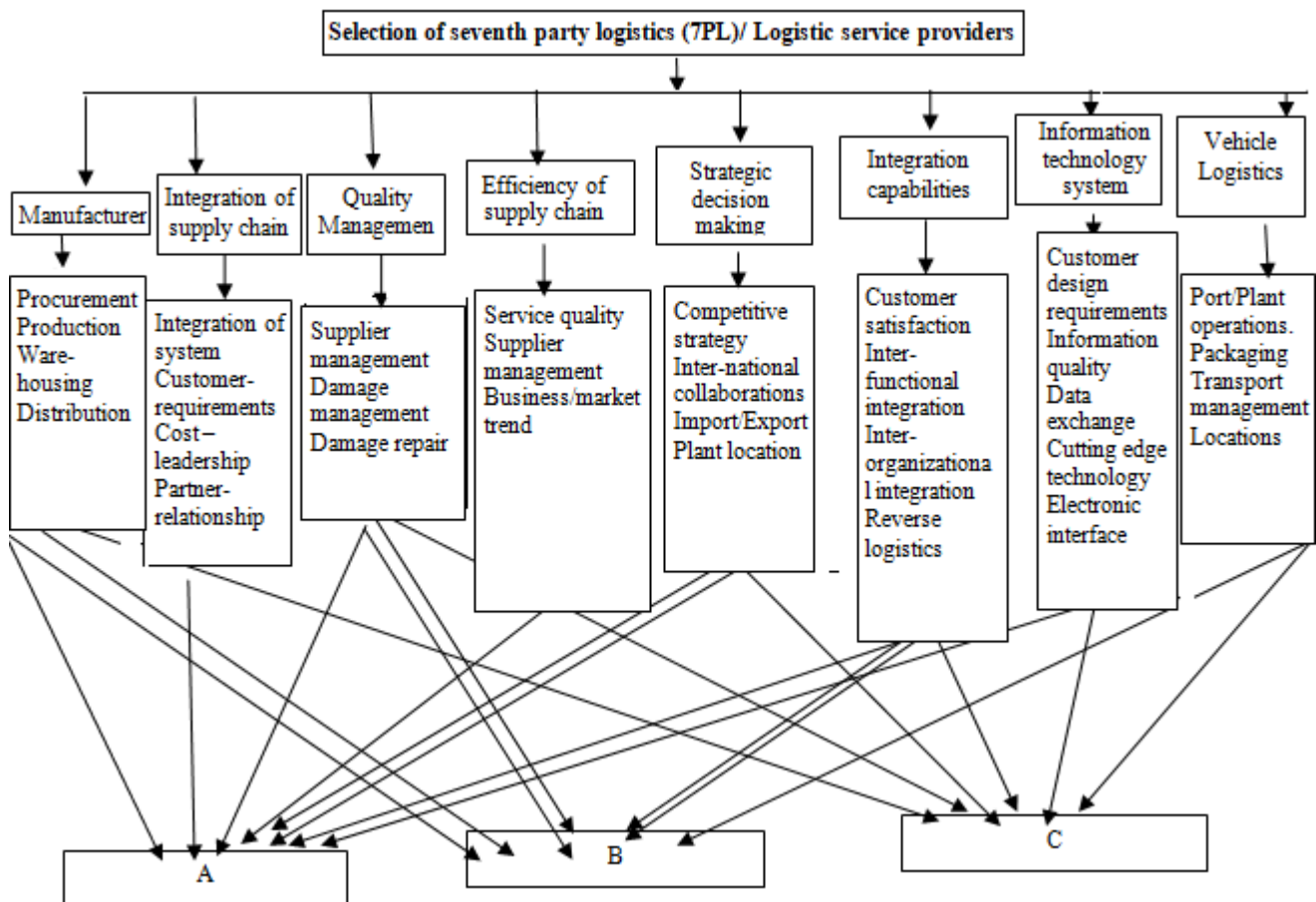
$$T(a) = \frac{\sum_{x \in A} IP(a,x)}{i-1}$$

Carefully selecting the criteria to be utilized in the decision-making process is necessary to ensure that most of the criteria characterize the problem at hand sufficiently and in

line with the demands made by the decision maker [Kolarević,6]. This minimizes the impact of the decision maker's subjective assessment and experience when choosing broad criteria.

2.2 PROMETHEE - II Ranking

The PROMETHEE method, which is the method developed and applied throughout the project, works similarly to all other outranking methods in that it starts with a pair-wise comparison of alternatives in each individual criterion to ascertain partial binary relations that indicate the degree of preference of an alternative (a) over (b). The PROMETHEE approach begins with the evaluation table.



3. Methodology

PROMETHEE I ranking is performed using the following steps:

Step 1: Using the decision maker's matrix and a questionnaire for each criterion, create a decision matrix. The importance of each criterion varies from the others, which influences the outcome.

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

$$R_{ij} = \frac{[x_{ij} - \min_i(x_{ij})]}{[\max(x_{ij}) - \min_i(x_{ij})]} \text{ and } R_{ij} = \frac{[\max(x_{ij}) - x_{ij}]}{[\max(x_{ij}) - \min_i(x_{ij})]}$$

Step 3: Determine the preference function Pj (a,b) by computing the evaluation difference of the ith choice relative to the other alternatives.

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

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

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

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

$$\phi^+ = \frac{1}{m-1} \sum_{b=1}^m \pi(a,b) \text{ when } (a \neq b) \text{ and } \phi^+ =$$

$$\frac{1}{m-1} \sum_{b=1}^m \pi(b,a) \text{ when } (a \neq b)$$

where m = number of alternatives.

Step 6: Partial ranking and comparison of options for the exiting (ϕ^+) and entering (ϕ^-) values. As a result, following a comparison of the (ϕ^+) and (ϕ^-) values, the partial ranking is calculated, and the final results are tabulated and final selection of the seventh logistics service provider from the rank.

PROMETHEE II ranking is performed using the following steps:

Step 1: Using the decision maker's matrix and a questionnaire for each criterion, create a decision matrix. The importance of each criterion varies from the others, which influences the outcome.

Step 2: Using the formulas, normalize the assessment matrix (decision matrix) as indicated

$$R_{ij} = \frac{[x_{ij} - \min(x_{ij})]}{[\max(x_{ij}) - \min(x_{ij})]} \text{ and } R_{ij} = \frac{[\max(x_{ij}) - x_{ij}]}{[\max(x_{ij}) - \min(x_{ij})]}$$

Step 3: Determine the preference function $P_j(a,b)$ by computing the evaluation difference of the i th choice relative to the other alternatives.

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

Step 4: Determine the total preference $\pi(a,b)$ using the table below as a guide.

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

Step 5: Calculate the numbers for the exiting flow (ϕ^+) and entering flow (ϕ^-) using the

$$\phi^+ = \frac{1}{m-1} \sum_{b=1}^m \pi(a, b) \text{ when } (a \neq b) \text{ and } \phi^- = \frac{1}{m-1} \sum_{b=1}^m \pi(b, a) \text{ when } (a \neq b)$$

where $m = \text{number of alternatives}$

Step 6: Compute the net outranking values for the entering flow (ϕ^+) and the departing flow (ϕ^-).

$$\phi(a) = \phi^+(a) - \phi^-(a)$$

Step 7: Ranking every option that is taken into consideration based on the values of $\phi(a)$. From the highest values of $\phi(a)$ logistic service provider will be chosen.

4. Results

$\phi_{(a)}$ for each of the three LSPs are obtained using the PROMETHEE method based on eight criteria and thirty-one sub-criteria. Based on these findings, LSP-A was found to

be the best option with the highest value of $\phi_{(a)}$, providing the most favorable logistic conditions. LSP-C and LSP-B came in second and third, respectively. The logistic competition level can be expressed as a percentage relative to other options using the $\phi_{(a)}$ index.

5. Conclusion

The study highlights the benefits of using a 7PL service provider for logistics management, such as how it can streamline coordination between various stakeholders, share transportation expenses and modes, guarantee last-mile distribution, improve responsiveness, and effectively coordinate tactical and operational logistics activities. The management must have complete knowledge of the service providers and their attributes, making the selection of service providers a difficult task. PROMETHEE and other MCDM techniques are used to rank the service providers.

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