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A Proposed Approach for Selecting Third Party Logistic Alternatives

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A R T I C L E I N F O

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A B S T R A C T

At present, the demand for a third-party logistics service provider has become an increasingly important issue for companies to improve customer service and reduce logistics costs. Third-party logistics is using another company to perform some tasks. There are many ways to select a third-party logistic provider, like Multi-criteria decision making, statistical approaches, mathematical programming, artificial intelligence, and hybrid method (or integrated method). This paper presents an ambiguous integrated approach for assessing and selecting third-party logistics service providers. This method consists of two phases, in phase one, Fuzzy Analytical Hierarchy Process (FAHP) is used to determine the weights of the evaluation criteria. In phase two, Technique for Order Preference by Similarity to Ideal Solution (TOPSIS) is used to evaluate alternatives, sequence them, and make the final selection. The objective is to minimize the effects of inaccuracies such as human judgment and preferences while searching for the best decision. Two methods are used to find the fuzzy set: extent analysis method and the geometric mean technique. In this paper, a survey was conducted on papers from 2014 to 2018 to find the most frequently used criteria, seven criteria were identified: reputation, information technology implementation, information sharing, service cost, reliability, quality, and geographic location.

1. Introduction

In recent years, the collaboration with exterior partners for any company in the present competitive business world is an important issue, or what is called ‘outsourcing’ [1]. Nowadays, the focus is on thinking about the best ways to obtain reliability, reduce cycle times, and achieve high levels of efficiency. Companies start to outsource one or more logistics functions to third party logistics (3PLs) providers to reduce costs. 3PL can enhance logistical procedures

by allowing companies to focus on their convenient core qualities that are likely to reduce production cost and enhance customer satisfaction [2]. Manufacturing industries are re-examining their supply chain management (SCM) structures in collaboration with external partners to improve the overall performance of the supply chain from a broader perspective to achieve greater commercial value. Concepts of successful supply chain practices require optimal management of the exchange of physical and information flows between all participants in the supply chain as managers (decision makers) aim to reduce costs as well as increase profits across the supply chain [3]. There is a growing interest in 3PL or logistical outsourcing among practicing managers and academics alike, as shippers around the world are outsourcing their logistics activities to reduce supply chain complexities, reduce costs and overheads and

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expand their global reach, which results in a higher level of customer satisfaction [4, 5].

According to [6], the quality and efficiency of the organization's logistics providers cannot be directly controlled by the organization. The only way to gain competitive advantage in "non-core" activities is by selecting the most appropriate and efficient provider among all the available options. According to [7] a company that provides services or products is called 'first party'; the second party is the customer (or client). The third party is a company that is mainly hired to do some of the jobs that neither the first party nor the second party is willing to do. 3PL provides logistical services from outside sources or 'third parties' to companies for some or all of the supply chain management functions such as warehousing and transportation services. These services can be scaled and customized according to customer needs, based on market conditions, ordering service, and delivery. 3PL has evolved from a previously dominant transactional role to one that is more strategic in nature. Choosing the right 3PL company is critical to the company and depends on a variety of factors. According to [8] the organization merits for using 3PL, include:

1. Saving time for organization and focus on its core competencies.
2. 3PL does not need to own storage facilities, vehicles or aircraft to perform duties such as quotations, reservations, directions or audits, as it is often leased on terms equivalent to the terms of a 3PL contract that reduce liability for capital expenditures.
3. Meeting global market demands and gaining a competitive advantage.
4. 3PL can do the job in a better and more professional way because 3PL companies are specialized,
5. The opportunity to present the perfect order every time.

However, the major disadvantages of using 3PL are the difficulty in finding reliable partners [9]. During the selection process of 3PL, logistics managers may encounter many problems such as:

1. How to determine the criteria for selecting 3PL providers?
2. How are the criteria prioritized? How to develop a hierarchical relationship between selection criteria?
3. How do you use expert knowledge to get the most benefit?

Hence, the selection process can be time consuming and generally costly. According to [10], 3PL activities have five main steps: (1) identifying the need to outsource logistics; (2) developing feasible alternatives; (3) evaluating candidates and selecting suppliers; (4) implementing service; and (5) continuous evaluation. Some of the advantages of outsourcing for an organization are to help reduce financial risk and achieve savings in capital investment and operational costs. Due to the complexity of the decision and the large number of criteria, various approaches have been used to analyze, evaluate and select 3PL partners. Multiple criteria decision-making approaches (MCDMs) are among the most popular [11]. Besides the introduction, this paper includes three sections. Section 2 provides a review of the literature on 3PL selection methods. In Section 3, the selection criteria are discussed. In Section 4, a framework and methodology are developed to suggest a method for selecting 3PL. Conclusions and recommendations are presented in Section 5.

2. Literature review

This section provides a literature review on 3PL evaluation and selection studies during the period 2013-2018 and review on criteria and their definitions.

Many researchers have conducted studies to select the suitable 3PL provider in logistics processes. According to recent reviews [12, 13, and 14], the selection methods for 3PL can be grouped in five categories:

1. Statistical approaches, such as correlation method and cluster analysis.
2. Mathematical programming, such as linear/nonlinear programming (LP/NLP), multi-objective programming (MOP), data envelopment analysis (DEA).
3. Artificial intelligence, such as case-based reasoning/ rule-based reasoning, data mining (CBR/RBR).
4. MCDM techniques, such as: Interpretive Structural Model (ISM) , multi-criteria optimization and compromise solution (VIKOR), Quality Function Deployment (QFD), Decision-Making Trial and Evaluation Laboratory (DEMATEL), Analytic Hierarchy Process (AHP), Analytic Network Process (ANP), Technique for Order Preference by Similarity to Ideal Solution (TOPSIS), Elimination and Choice Expressing Reality (ELECTRE), utility theory, and Fuzzy Sets Theory (FST).
5. Hybrid methods (integrated methods).

In 1973, Warfield proposed an ISM to analyse complex socio-economic systems [15]. ISM enables individuals or groups to develop a map of the complex relationships between the many elements involved in a complex situation [16]. For example, in [17], ISM was used in evaluating and selecting 3PLs based on twelve criteria. The results indicated that cost was the most dependent and least driving force, while the largest and least dependent driving force was financial stability.

The VIKOR method was introduced in 1998, and the VIKOR method is based on a special measure of "proximity" to a "perfect" solution. The VIKOR method is an effective tool for finding a compromise from a set of conflicting criteria [18]. QFD is a technology that transforms customer needs or customer voice into technical requirements using a House of Quality (HOQ) matrix that summarizes the relationship between customer traits and product characteristics [19].

The AHP method is one of the most used MCDM methods which can be used to determine the best alternative. AHP allows decision makers to start from pairwise comparisons that are simple enough to work with and often favoured by the decision. The method takes into account the intangible criteria as well as the tangible criteria. Weight, financial performance, reputation and long-term relationships are the most important factors in choosing a 3PL company [20]. For example, in [21] the AHP method was used in the pharmaceutical industry, and relative weights of four criteria and twelve subcategories were assigned for selecting the most important ones; it was found that the most important criteria are expertise, risk management, information technology, and relationship. The AHP program is flexible enough to incorporate both qualitative and quantitative factors. In [22], AHP method was applied to classify high-tech manufacturers in Taiwan according to the importance of selection criteria, and it was found that the three criteria groups with the greatest influence on selection are performance, cost and service. Sensitivity analysis helps decision-makers see the effect of potential data changes and/or miscalculations on their pairwise comparisons. According to [23], “sensitivity analysis is as important as finding the best solution”.

According to [24], ANP is a multi-criteria decision analysis technique that can capture interdependencies between decision attributes. Factors for assessing logistics performance are interrelated. ANP is a series of pairwise comparisons in order to obtain the relative importance of these traits.

TOPSIS, one of the classic MCDM methods, was suggested by [25]. TOPSIS is based on the concept that the alternative chosen should have the shortest distance from the positive ideal solution (PIS) and the furthest from the passive ideal solution (NIS) to solve the MCDM problem [26].

The DEMATEL method can deal with significance and causal relationships between criteria; it has the ability to display the interrelationships between norms and arrange them on the basis of their relationships. However, DEMATEL cannot deal with lack of information, expressions of ambiguous values, conflicting opinions, or uncertain positions [27]. Developed in 1968, ELECTRE is a higher order method, suitable for solving problems such as Logistics Service Providers (LSPs) selection due to its ability to deal with qualitative and quantitative criteria, manage compensatory effects, and understand relationships between criteria. The ELECTRE method was developed to determine the order of preference among a discrete set of substitutions related to a set of criteria [28]. Some researchers have addressed the integration of two methods such as DEMATEL with TOPSIS, FUZZY AHP with FUZZY TOPSIS, and AHP with TOSIS. Table 1 illustrates some of the literature that has used different methods of selecting and evaluating 3PL.

In [29]; integrated method (DEA& TOPSIS& LP) is used to find the best 3PL; DEA is used to evaluate the efficiency of each vendor according to the identified criteria. Second, TOPSIS is applied to rank the maximally efficient vendors. Finally, LP problem is stated and solved to ascertain the quantities to be allocated to each maximally efficient vendor in the context of multiple logistics provider. In [5]; integrated method (DEA & ANP) for evaluating and selecting methodology to select an efficient and requisite 3PL. DEA effectively screens the maximally efficient 3PLs and ANP easily performs the cumbersome process of weighting diverse criteria and ranks various alternatives according to their performance on the basis of these criteria. In [5], four input criteria were used; transportation, capacity/strength, vehicle type and quality, and driver rejection, three output criteria were identified; performance, flexibility, and lead time among 26 3PLs alternatives. In [14]; an integrated method (AHP&TOPSIS) is used to evaluate 3PL providers, AHP for calculating the weights of criteria, and then TOPSIS method is employed to achieve the final ranking results. Six criteria were used; cost of service, - service level, level of professionalism, geographical location, specific references in the same sector, and innovation capacity and collaboration with the customer.

3. Different selection criteria

Many researches have used different criteria; they are summarized in Table 1.

Table 1: different criteria and their definitions

Criteria	Ref	Definition
Reputation	[30], [11], [2], [25], [1], [31] [3] [32] [33]	It is one of the components of identity as others identified. Reputation is an essential tool of the social system, based on the distributed social control and spontaneous.
IT application and information sharing	[17], [34], [11], [25]; [1], [30], [31], [32]	Sharing information is a platform that provides data for the exchange of information between the customer and supplier through the policies and guidelines to maintain pre-defined standards on privacy, security, and data quality.
Cost of service	[30], [30], [35], [22]; [1], [31], [32] [3], [36]	Price (cost of service) is a specific key in the purchase decision. It includes the total cost of outsourcing logistics and related terms include low distribution cost, price, cost reduction, operational cost, order processing cost, warehouse cost and cost saving.
Reliability	[17], [34], [35], [1], [3] [36] [32]	This standard ensures that products or services are reliable and can contribute to customer satisfaction in general.
Quality	[30] , [34], [5], [22] [31] [33]	The high-quality representation of management through decisions taken by managers to maintain a long-term relationship with customers.
Geographical location	[14], [30] [31] [17], [34] [3]	They include market coverage and international shipping capabilities and perspectives, geographical specialties and a range of services provided by 3PLs.
Service level	[14], [30], [22] [34]	It includes problem-solving, value-added service, customer support, and service capability
Managing assets and infrastructure	[17], [35] [31] [36]	3PL's fixed assets include availability of appropriate physical machinery or types of equipment of acceptable size and quality, which helps in delivering duties or services to the level of customer satisfaction.
Performance of 3PL with desired output	[5], [22], [31], [32]	It depends on providing the services or goods in time, reliability and quality of delivery. This results in higher performance that increases reputation and market share.
Long-term relationships	[11], [20], [31], [33],	It indicates the development of trust, sharing of incentives, rewards and risks. Also, to get a good level of cooperation and communication between the customer and the 3PLs. Helps improve reliability, reliability, alignment, and compatibility.
Financial Position (FP)	[30], [20], [31]	Shows the financial situation of the proper continuation of the quality of services and regular update of the machine.
Transportation	[5], [34], [11]	This standard deals with the cost of using the vehicles. It represents how much a 3PL fee is for carrying. Obviously, the lower the price, the best the 3PL.
Level of professionalism	[14], [30], [32]	If the 3PL provider is an expert in providing logistics services, the company will be more confident and easier to cooperate with. This standard has characteristics such as experience and competence. Also, the 3PL provider must demonstrate sound knowledge of services in the industry, punctuality and courtesy towards their clients in the way they interact and provide to clients.
Delivery	[30], [1] [32]	Provide a product or service that meets customer requirements and specifications within delivery time. On-time delivery is measured as a percentage of completion during a time window that brackets the customer's required date and /or business commitment date, and is not optimized by quoting long lead times.
Performance or responsiveness	[22], [31], [36]	On-time delivery, document accuracy, transportation safety, and shipment error rate are measures of vendor's performance based on delivery times, delay in internal

		approvals, quality processes, distribution network selection, after-sales service, transportation process selection, and resource utilization.
Operational performance	[31], [35], [33]	Improves potential problem-solving ability, error diagnosis, response, system security, long-term business relationship, and confidentiality of sensitive data
Committed management and workforce	[17], [31]	Every employee is an integral component of a company. A satisfied employee improves the performance
Compatibility	[20], [31]	Compatibility with the company's culture, vision and values provides ease of work and flexibility. It also improves the long-term and productivity relationship of the enterprise
Specific references in the same sector	[14], [31]	It helps in on-time delivery, obtaining internal commercial approvals, developing process quality control, designing a suitable distribution network, improving after-sales service, improving transportation methods, providing optimum quantity, and correct use of internal resources.
Managing inventory integration	[17], [11]	Multi-inventory represents stages in the form of raw materials and the accounts of the process of running full-made goods more than 85 percent of the working capital, and thus represents the final cost of the product. Service helps original equipment providers (OEMs) in stock management through the integration of stocks in the session and through the provision of supply and scheduling solutions.
Knowledge & experience	[11], [1]	Factory achievements in the past in relation to the provided service or product will be evaluated in this standard.
Flexibility	[32], [33]	This is related to the ability to adapt to the changing customer requirements. Subject to flexibility, it will include the ability to meet future requirements, the ability to assimilate and grow the client's business, the ability to handle specific business requirements, and the ability to respond to time.

4. Methodology and case study

Given some issues with MCDM, such as subjectivity, uncertainty, and ambiguity in the evaluation process [12], the proposed approach incorporates two methods: FAHP and TOPSIS. The FAHP is used to assign a weight to the decision elements of 3PLs and TOPSIS is used to determine the order preference for 3PLs (ranking). The combination of fuzzy AHP and TOPSIS helps evaluate alternatives according to decision-makers' preferences. The use of Fuzzy-AHP weights in TOPSIS makes decisions more realistic and reliable, especially when performance reviews are vague and imprecise. Two phases are used with ten steps applied to find the best 3PL as follows:

4.1 Phase 1 (FAHP)

Two methods are used to solve fuzzy AHP;

I. Chang's (1992) Extent Analysis Method [37]: Fuzzy AHP is used for obtaining more decisive judgments by prioritizing the selection criteria and weighting them in the presence of vagueness in the problems. According to Ziaei and Hajizade [38], the steps for FAHP are:

Let X be an object set; X = {x1, x2, …… xn},
G is a goal set, G = {g1, g2, ……. gm}.

An extent analysis value for each object can be obtained.

TFNs can be expressed as $A_{gi}^1, A_{gi}^2, \ldots, A_{gi}^n$, $i = 1,2, \ldots, n$, where all A_{gi}^j, $j = 1,2, \ldots, m$.

Step 1. The value of fuzzy synthetic extent with respect to the i^th^ object is defined by:

$$Z = \sum_{j=1}^{m} A_{gi}^{j} \otimes \left[\sum_{i=1}^{n} \sum_{j=1}^{m} A_{gi}^{j} \right]^{-1} \quad (1)$$

To obtain $\sum_{j=1}^{m} A_{gi}^{j}$, perform the fuzzy addition operation of A-extent analysis values for a particular matrix such that:

$$\sum_{j=1}^{m} A_{gi}^{j} = \left[\sum_{j=1}^{m} a_j, \sum_{j=1}^{m} b_j, \sum_{j=1}^{m} c_j \right] \quad (2)$$

To obtain $\sum_{i=1}^{n} \sum_{j=1}^{m} A_{gi}^{j}$, perform the fuzzy addition operation of A-extent analysis values for a particular matrix such that:

$$\sum_{i=1}^{n} \sum_{j=1}^{m} A_{gi}^{j} = \left[\sum_{j=1}^{m} a_j, \sum_{j=1}^{m} b_j, \sum_{j=1}^{m} c_j \right] \quad (3)$$

And then calculate the inverse of this vector. The degree of possibility of $A_1 = (a_1, b_1, c_1)$, $A_2 = (a_2, b_2, c_2)$ can be determined as:

$$V(A_2 \geq A_1) = hgt(A_1 \cap A_2) = c_2 \quad (4)$$

Figure 1 shows the intersection between A_1 and A_2, where d is the ordinate of the maximum intersection point D between c_1 and c_2, both values of $V(A_2 \geq A_1)$ and $V(A_1 \geq A_2)$ are required to compare A_1 and A_2.

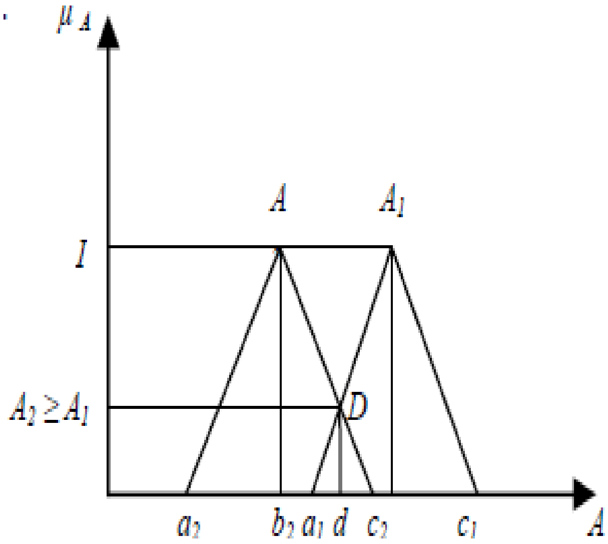

Figure 1. The intersection between $A_2\ and A_1$

Step 2. The degree of possibility for a convex fuzzy number to be greater than K convex fuzzy number A (i = 1, 2… k) can be described by $V(A \geq A_1, A_2, \dots, A_K) = V(A \geq A_1)\ \&\ V(A \geq A_2)\ \&\ V(A \geq A_K) = \min V(A_i \geq A_k),\ i = 1,2,3, \dots, k$.

Hypothesize that

$d'(A)_i = minV(A_i \geq A_k)\ for\ k = 1,2,3, \dots. n, k \neq i$

Then, the weight vector is expressed by W'=$(d'(A_1), d'(A_2), \dots, d'(A_n))T$,

where $A_i = 1,2, \dots, n$ are n factors.

Calculating the normalized weight vector by

$W = (d(A_1), d(A_2), \dots, d(A_i))^T$ where W is a non-fuzzy number.

II. Geometric mean technique and then fuzzy relative weight matrix:

Geometric mean is calculated for each row of Ã and then fuzzy relative weight matrix is deduced by Singh [34].

Geometric mean of each row of Ã is given by Equation (5):

$$\tilde{A} = \begin{pmatrix} 1 & \tilde{a}_{12} & \cdots & \tilde{a}_{1n} \\ \tilde{a}_{21} & 1 & \cdots & \tilde{a}_{2n} \\ \vdots & \cdots & \ddots & \cdots \\ \tilde{a}_{n1} & \tilde{a}_{n2} & \cdots & 1 \end{pmatrix} = \begin{pmatrix} 1 & \tilde{a}_{12} & \cdots & \tilde{a}_{12} \\ 1/\tilde{a}_{12} & 1 & \cdots & \tilde{a}_{2n} \\ \vdots & \cdots & \ddots & \cdots \\ 1/\tilde{a}_{1n} & 1/\tilde{a}_{2n} & \cdots & 1 \end{pmatrix} \quad (5)$$

Where

$$\tilde{a}_{ij} = \begin{cases} \left(\frac{1}{a_i}, \frac{1}{b_i}, \frac{1}{c_i}\right) & \forall_i < j \\ (1,1,1) & \forall_i = j \\ (c_i, b_i, a_i) & \forall_i > j \end{cases} \quad (6)$$

$$\left(\tilde{a}_{i1} \otimes \dots \otimes \tilde{a}_{ij} \otimes \dots \otimes \tilde{a}_{in}\right)^{\frac{1}{n}} \tilde{r}_i = \quad \forall_i = 1,2,3, \dots, n \quad (7)$$

$$\tilde{W}_i = \tilde{r}_i \otimes \left(\tilde{r}_1 \oplus \dots \oplus \tilde{r}_i \oplus \dots \oplus \tilde{r}_n\right) \quad \forall_i = 1,2,3, \dots, n \quad (8)$$

Where $\tilde{a}_{in}$ is a fuzzy comparison value of the criterion i to criterion n, thus, $\tilde{r}_i$ is geometric mean of fuzzy comparison value of the criterion i to each criterion, $\tilde{w}_i$ is the fuzzy weight of the ith criterion, can be indicated by TFN.

Thus, we get an n x 1 relative weight matrix w. Each element of this matrix consists of a triangular fuzzy number, $\tilde{w}_i = (aw_i), bw_i, cw_i)$

4.2 Phase 2 (TOPSIS)

Step 3: Estimating the relative weights of the decision elements.

According to Perçin [39], TOPSIS measures the shortest distance from the ideal solution and the furthest distance from the passive ideal solution. The TOPSIS stage starts on the proposed model from a weighted measured decision matrix from the FAHP stage of the corresponding criteria. Positive ideal solutions (PIS) are found as the maximum and minimum values of the weighted measured elements in each column for the benefit criteria, and their inverse of the cost criteria are used for the negative ideal solution (NIS).

Step 4: Calculating the normalized decision matrix from relative weights of FAHP [40].

Evaluating the decision matrix with *m* alternatives and *n* criteria:

$$D = \begin{bmatrix} a_{11} & a_{12} & \dots & a_{1j} & \dots & a_{1n} \\ a_{21} & a_{22} & \dots & a_{2j} & \dots & a_{2n} \\ \dots & \dots & \dots & \dots & \dots & \dots \\ a_{i1} & a_{i2} & \dots & a_{ij} & \dots & a_{in} \\ \dots & \dots & \dots & \dots & \dots & \dots \\ a_{m1} & a_{m2} & \dots & a_{mj} & \dots & a_{mn} \end{bmatrix} \quad (9)$$

Where a_{ij} shows the rating of the i^{th} Decision Making Unit (DMU) with respect to the j^{th} criteria. $i = 1,2,3, \dots, m$ is the number of *DMU* and $j = 1,2, \dots, n$ is the number of criteria. The normalized decision matrix is calculated as:

$$r_{ij} = \frac{a_{ij}}{\sqrt{\sum_{i=1}^{m} a_{ij}^2}} \qquad i = 1,2, \dots m; j = 1,2, \dots n \quad (10)$$

Where R is the normalized matrix of elements r_{ij}

$$R = [r_{ij}] \quad (11)$$

Step 5: Calculating the weighted normalized decision matrix.

Constructing the weighted normalized matrix by multiplying the elements by weights of corresponding criteria as:

$$V_{ij} = r_{ij} * W_j \quad (12)$$

Where V_{ij} is the weighted normalized matrix and W_j is the weight (from fuzzy AHP) for the j^{th} criteria.

Step 6: Determining the ideal and negative-ideal solution

Determining the positive V_j^+ and negative ideal V_j^+ solutions by finding the maximum and minimum values of weighted normalized elements in each column:

$$V_j^+ = \{(maxV_{ij} / i \in I).(minV_{ij} / i \in I)\} \text{ for each } j \quad (13)$$

$$V_j^- = \{(minV_{ij} / i \in I).(maxV_{ij} / i \in I)\} \text{ for each } j \quad (14)$$

Where I is associated with benefit criteria and J is associated with cost criteria.

Step 7: Calculating the separation measures.

Calculating the separation measures for each alternative using n-dimensional Euclidean distance. The positive ideal distance measure is given by:

$$s_i^+ = \sum (V_{ij} - V_j^+)^2 \; ; i = 1.2 \ldots .m; \text{and } j = 1.2 \ldots .n \quad (15)$$

The negative ideal distance measure is given by:

$$s_i^- = \sum (V_{ij} - V_j^-)^2 \; ; i = 1.2 \ldots .m; \text{and } j = 1.2 \ldots .n \quad (16)$$

Step 8: Calculating the relative closeness to the ideal solution.

Calculating the relative closeness to ideal solution:

$$C_i = \frac{s_i^-}{s_i^- + s_i^+}; \quad 0 \le C_i \le 1. \quad i = 1.2 \ldots .m \quad (17)$$

$$S_i- \text{ and } S_i+ \ge 0 \quad (18)$$

Step 9: Ranking the preference order

Rank the preference order as C_i

4.3 Case study

According to [20], there are three alternatives for the company. Company A, Company B and Company C. there were four important criteria compatibility C1, long-term relationship C2, financial performance C3, and reputation C4. Numerical data are shown in Tables 2-6.

Table 2: Criteria pair wise comparisons.

	C1	C2	C3	C4
C1	1	4	2	3
C2	¼	1	1/2	1/2
C3	½	2	1	2
C4	1/3	2	1/2	1

Table 3: Alternatives' pair wise comparisons compatibility criteria

C1	A	B	C
A	1	1/6	1/2
B	6	1	4
C	2	1/4	1

Table 4: Alternatives' pair wise comparisons long term relationship criteria

C2	A	B	C
A	1	1/3	1
B	3	1	3
C	1	1/3	1

Table 5: Alternatives' pair wise comparisons financial performance criteria

C3	A	B	C
A	1	5	1/3
B	1/5	1	1/9
C	3	9	1

Table 6: Alternatives' pair wise comparisons reputation criteria.

C4	A	B	C
A	1	4	6
B	¼	1	2
C	1/6	½	1

According to the steps for the two phases AHP and TOPSIS proposed approach, two methods were used. Using the first method, spectrum analysis, 3PL provider "B" obtained the largest relative convergence value, the long-term relationship criteria and evaluation criteria are more important than other criteria. Using the second method, the average engineering technique, the 3PL provider "A" obtained the largest value for relative convergence and the standards of compatibility were higher.

5. Conclusions

Outsourcing has become a common practice in many industries, specifically in logistics activities. As more companies are outsourcing their logistics processes, selecting appropriate and preferred 3PL customer service providers have become an important issue and strategic decision for companies to outsource their logistics operations.

In this study, we provide a proposed integrated method approach as a decision-making tool that can be implemented by companies which need the services offered by 3PL providers as an outsourcing activity. The proposed integrated method combines FAHP and TOPSIS and two methods (extent analysis method and the geometric mean technique) to find the fuzzy set. The combination of FAHP and TOPSIS helps evaluate alternatives according to decision-makers' preferences. The use of Fuzzy-AHP weights in TOPSIS makes decisions more realistic and reliable, especially when performance reviews are vague and inaccurate. The FAHP is used to assign a weight to the decision elements of 3PLs and TOPSIS is used to determine the order preference for 3PLs (ranking). In this paper, the most important criteria were found to be reputation, IT application and information sharing, cost of service, reliability, Quality, and geographical location.

For further studies, other methods may be applied to the problem like integrated approach fuzzy AHP and fuzzy TOPSIS then compared with obtained results in this study. Applying sensitivity analysis is key for a deeper understanding of the reliability of the results.

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