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Multi-Criteria Decision Making in Selection of Seventh Party Logistics Using AHP

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Abstract
In today's industrial scenario, the expectations and demand of customers are reaching great heights. In order to satisfy the customer requirements, the users are increasingly turning towards seventh party logistics (7PL) service providers to manage their total supply chain operations. In this present research, initially, the criteria for the selection of integrated service providers have been identified and an integrated modal based on their inter-relationship has been developed with help of shippers. With this idea of what factors to be considered and their inter-relationships while selecting integrated service provider. Later, various methods deriving the priority weights viz. Analytical Hierarchy Process (AHP) have been employed for 7PL service provider selection. The derived priorities of 7PL alternatives using methods have been critically analyzed and compared for effective selection. The use of the model indicates that the computed quantitative evaluation can be applied to improve the precision of the selection.

Keywords: Analytical Hierarchy Process, Seventh party logistics, priority weight, criteria selection.

1. Introduction

Ever increasing competition in today's global markets, the introduction of products with shorter life cycles, faster dissemination and proliferation of information, and heightened expectations of customers have forced business organizations to invest in, and focus attention on, their entire supply chain. The concept of 7PL stems from the very simple notion of amalgamating the well-established 3PL domain with the concept of 4PL, originally coined and trademarked by Accenture. The AHP has found its widest applications in multi-criteria decision making, in-planning and resource allocation and in many other fields. This methodology is made up of the following steps.

• Structuring of the problem into a hierarchy
• Comparative judgment
• Synthesis of the priorities

The major advantage of the hierarchical structure is that it allows for a detailed, structured and systematic decomposition of the overall problem into its fundamental components and interdependencies, with a large degree of flexibility. The massive diffusion of these techniques has promoted the development of hybrid approaches in which one or more steps of the AHP [1].

The adopted hierarchical schema is composed by four hierarchical levels (main goal; attributes; characteristics; alternatives). A case Problem was undertaken to ascertain the selection of integrated service providers (ISP's) / 7PL for a multinational company (MNC).7PL is combination of 3PL and 4PL. Scope of 4PL is limited to supply chain consultation, selection of 3PL, analytics, demand supply planning, MIS etc. but all 3PL activities like warehousing, physical distribution, coordination with transporter, Fleet operators, clearing agents might not performed by them. All these activities of both 3PL and 4PL are combined to perform 7PL operations.

AHP method was developed by Saaty and consists of a systematic approach based on breaking the decision problem into hierarchy of interrelated elements. The evaluation of selected attributes is done by a scaling system that each criterion is related to other. This scaling process is converted into priority Analytical Hierarchy Process (AHP) is an approach to decision making that involves structuring multiple choice criteria into a hierarchy, assessing the relative importance of these criteria, comparing alternatives for each criterion, and determining an overall ranking of the alternatives [2].. The priority scale may be that of an individual decision-maker or a decision making team. . Confidence levels for consistency and concordance measures are based on tabulated test statistics and on empirical standards. Decisions: the paired comparison technique.

2. Steps in AHP

-Decomposition

The goal is structuring the problem into humanly-manageable sub-problems. To do so, iterating from top (the more general) to bottom (the more specific), split the problem which is unstructured at this step, into sub-modules that will become sub-hierarchies. Navigating through the hierarchy from top to bottom, the AHP structure comprises goals (systematic branches and nodes), criteria (evaluation parameters) and alternatives ratings (measuring the adequacy of the solution for the criterion).
Each branch is then further divided into an appropriate level of detail. At the end, the iteration process transforms the unstructured problem into manageable organized both vertically and horizontally under the form of a hierarchy of weighted criteria. By increasing the number of criteria, the importance of each criterion is thus diluted, which is compensated by assigning a weight to each criterion [3].

- Weighing

Assign a relative weight to each criterion, based on its importance within the node to which it belongs. The sum of all the criteria belonging to a common direct parent criterion in the same hierarchy level must equal 100% or 1.A global priority is computed that quantifies the relative importance of a criterion within the overall decision model.

-Evaluating

Score alternatives and compare each one to others. Using AHP, a relative score for each alternative is assigned to each leaf within the hierarchy, then to the branch the leaf belongs to, and so on, up to top of the hierarchy, where an overall score is computed.

- Selecting

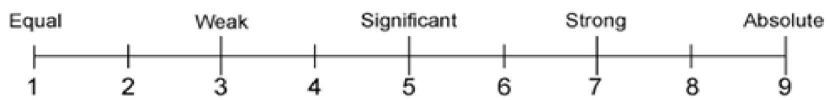
Compare the alternatives and select the one that best fits the requirements.

3. AHP Methodology

Saaty's priority theory of analytical hierarchy process (AHP) was developed to weigh the significant factors in a decision problem through pair wise comparisons. The relative significance of a pair of the factors (or criteria's) is displayed in a matrix. Finally, the weighs (also called as priorities) of the factors are obtained by an eigen value analysis. In a nomination procedure one usually has to face a two-level decision problem. First, the significant factors (i.e. decision criteria) must be identified and subsequent weights (priorities) must be assigned o them, either in quantitative or qualitative manner. Second, the candidates (also called as alternatives) are to be compared and considering each of factors separately, their relative's capability must be established. At both the levels, priority theory can be used. At first level, it is applied only once, at the second level for each level separately. Advantages and Limitations of AHP.

Advantages	Limitations
• AHP Provides quantitative model to integrate qualitative information and quantitative values and analysis. • AHP is conceptuallyeasy to useand it sis decision robust.	• AHP assumes the system elements are uncorrelated and are unidirectional influenced by a hierarchy relationship. • AHP model a decision making frame work that assumes a unidirectional hierarchy relationship among decision levels.

Finally, adding the priorities per candidate weighted by the priorities of the significant factors, one obtains s a score (also called as final value) for each candidate. The highest score designates the candidate to be nominated (to achieve desired goal).
AHP is an intuitively simple methodology, which helps in formulating and analyzing the complex situation by simplifying it to provide an ease in decision making.
It uses the numerical rating from the pair wise comparisons thus establish a priority or importance weight for each criterion. AHP also allows decision makers to make qualitative decision objectively, and enables systematic decision making by expressing the interaction and hierarchy of factors. Hence, this study adopted AHP to analyze the performance of 7PL service providers to establish competitive market position. The decision-maker either compares all pairs of items exhaustively, or more usually, a valid sample of pairs of items under the judgement analysis sampling plan.
The decision-maker compares the items in terms of a continuous, 9-point, stimulus-centered judgement scale:



The main procedure to assign the relative importance and to check the consistency made in the judgments is as follows:

Construction of pair wise comparison matrix using a scale of relative importance

The relative importance between the two criteria (i.e.) is assigned an appropriate value using Saaty's scale [4]. The pair-wise comparison intensity of relative importance between two criteria can be established using Table1

Table 1: Saaty's scale (1980).

Intensity of relativeimportance	Definition
1	Equally preferred
3	Moderately preferred
5	Essentially preferred
7	Very strongly preferred
9	Extremely preferred
2,4,6,8	Intermediate importance between two adjacent judgments

Assuming M criteria, the pair-wise comparison of criterion I with criterion j gives a square matrix $A^1_{MxM}$where a_{ij} denotes the relative importance of the criterion I with respect to criterion j. In the matrix, $a_{ij}=1$ when i=j and $a_{ij}=1/a_{ij}$. When i≠j

Normalizing weight (W_i) of each criterion

The relative normalized weight (W_i) of each criterion may be obtained by calculating the geometric mean ofi^{th} row and normalizing the geometric means of the rows in the comparison matrix.

$GM_i =(\Pi^M_{j=1} a_{ij})^{1/M}$

and

$W_i= GM_i / {}^M_{j=1}\sum GM_j$

Calculation of eigen value matrix

Construct matrix A_3 and A_4 such that $A_3=A_1xA_2$ and $A_4=A_3/A_2$,

Where, $A_2=[W_1 ,W_2,\ldots\ldots\ldots,W_i, Wn]^T$.

Finding the maximum eigen valueλ_{max}.

The maximum eigen value λ_{max}. may be obtainedby calculating the average ofmatrix A_4.

Calculation of the consistency index C.I.

The consistency index may be obtained by using the equation

$C.I.=(\lambda_{max}-M) /(M -1)$

The smaller the value of the C.I deviation from the consistency is less.

Calculation of the random index R.I.

R.I. may be obtained for the number of criteria used in the decision making

Calculation of the consistency ratio

Consistency ratio may be obtained from C.R. = C.I. /R.I.; usually a C.R. of 0.1 or less is considered as acceptable as it reflects an informed judgment which could be attributed to the knowledge of the analyst about the problem under the study.

Calculation of priority weight for each alternative.

The priority weight for each alternative can be obtained by multiplying matrix of evaluation ratings by the vector of attribute weight and summing overall attributes. Expressed in conventional mathematical notation [5];

Weighted evaluation for alternatives, $k=\sum^i_{i=1}$ (attribute weight x evaluation rating $_{ik}$).

Where i= 1, 2………, t.

T=total number of alternatives.

4. Analytical Hierarchy Process (AHP) Model

In the model developed phase of the AHP the following step by step procedure has to be followed.

A Framework for Criteria Selection

Based on the literature survey [6, 7, 8] and discussion with the decision makers (team of experts from academia and industry), a list of criteria have been identified and an appropriate hierarchy of the AHP model consisting of the goal, criteria, sub-criteria and the alternatives, is formulated. The goal, which is placed on the first level, is to select the integrated service providers.

The second level of the hierarch occupied the criteria to achieve the goal. There are three criteria related to the destination, namely Integrated, Supply Chain Efficiency, Information Technology and Strategic Decision Making.

The third level consists of 19 sub-criteria which are all qualitative that are grouped with respect to the 3 criteria occupying the second level. The lowest level of the hierarchy consists of the alternatives, namely the different 7PL or integrated service providers as the shipper wants to evaluate before selecting the best service provider.

B Measurement and data collection

The nine-point scale as suggested by Saaty is used to assign pair wise comparisons of all elements in the second level of hierarchy and the sub-criteria which derive from the same criteria. The decision maker assigns his pair wise comparisons, which is then translated into the corresponding pair wise comparison judgment matrices (PCJM). A questionnaire consisting of all the criteria and sub-criteria is used to collect the pair wise comparison judgments from the decision maker. This questionnaire has been filled by the respondents by mailing them as an email attachment by personally meeting them. The total number of responses was 13 thus comprising to 14% of the total questionnaires send, out of which six industries and rest from academia. The decision makers have given the pair wise comparison judgments of all the criteria pairs and sub-criteria pairs that have the same criteria in the second level. The pair wise comparison judgment is made with respect to attributes of the next higher-level hierarchy, mainly about the criteria level and sub-criteria level.

The results collected from the questionnaire are used to form the corresponding pair wise comparison judgments (PCJM's) for determining the normalized weights. The AHP is a powerful and flexible multi-criteria decision-making tool for dealing with complex problems where both qualitative and quantitative aspects need to be considered. The AHP helps analysts to organize the critical aspects of a problem into a hierarchy rather like a family tree.The essence of the process is decomposition of a complex problem into a hierarchy with goal (criterion) at the top of the hierarchy, criteria and sub-criteria at levels and Sub-levels of the hierarchy and decision alternatives at the bottom of the hierarchy. Elements at given hierarchy levels are compared in pairs to assess their relative preference with respect to each of the elements at the next higher level.

Thiscomputes and aggregates their eigenvectors until the composite final vector of weight coefficients for alternatives is obtained. The entries of final weight coefficients vector reflect the relative importance (value) of each alternative with respect to the goal stated at the top of the hierarchy. A decision maker may use this vector according to his particular needs and interests. To elicit pair wise comparisons performed at a given level, a matrix *A* is created in turn by putting the result of pair wise comparison of element *i* with element *j* into the position *aji* as below.

$$A = \begin{array}{c} \\ C_1 \\ C_2 \\ C_3 \\ C_4 \\ C_5 \\ C_6 \\ . \\ C_n \end{array} \begin{array}{c} \begin{array}{cccccccc} C_1 & C_2 & C_3 & C_4 & C_5 & C_6 & . & C_n \end{array} \\ \begin{bmatrix} 1 & a_{12} & a_{13} & a_{14} & a_{15} & a_{16} & . & a_{1n} \\ a_{21} & 1 & a_{23} & a_{24} & a_{25} & a_{26} & . & a_{2n} \\ a_{31} & a_{32} & 1 & a_{34} & a_{35} & a_{36} & . & a_{3n} \\ a_{41} & a_{42} & a_{43} & 1 & a_{45} & a_{46} & . & a_{4n} \\ a_{51} & a_{52} & a_{53} & a_{54} & 1 & a_{56} & . & a_{5n} \\ a_{61} & a_{62} & a_{63} & a_{64} & a_{65} & 1 & . & a_{6n} \\ . & . & . & . & . & . & 1 & . \\ a_{n1} & a_{n2} & a_{n3} & a_{n4} & a_{21} & a_{21} & . & 1 \end{bmatrix} \end{array}$$

Where
n = criteria number to be evaluated

Ci = i. criteria,

Aij = importance of i. criteria according to *jth* criteria

After obtaining the weight vector, it is then multiplied with the weight coefficient of the element at a higher level (that was used as criterion for pair wise comparisons). The procedure is repeated upward for each level, until the top of the hierarchy is reached [5]. The overall weight coefficient, with respect to the goal for each decision alternative is then obtained. The alternative with the highest weight coefficient value should be taken as the best alternative. Saaty's AHP, is a well-known decision-making analytical tool used for modeling unstructured problems in various areas, e.g., social, economic, and management sciences [9, 10]

C. Selection of the Best 7pl Service Provider:

After computing the normalized priority weights from each PCJM of the AHP hierarchy, the next phase is to synthesize the solution for the integrated service provider selection problem. The normalized local priority weights of criteria and sub-criteria obtained from the above phase are combined together to obtain the global composite priority weights of all the elements of the lowest level. The priority weights are the evaluations of the integrated service provider selection which are being selected. In order to apply the developed model, the data regarding any three integrated service provider selection has been taken from an MNC. Since the criteria being qualitative, the data is not in the form of the quantifying figures. Instead, the general values have been given to criteria with a maximum of 1. The data collected in terms of sub-criteria for the three service providers. The data obtained is standardized before calculating the final evaluations by the linear weighted value of all the sub-criteria.

5. Conclusion

In the initial stage the criteria for selection of the integrated service providers have been identified and an integrated modal based on their inter-relationships has been developed with shippers. From the modal it is observed that all the criteria influence the selection of the integrated or 7PL service providers, since there are no criteria falling in the autonomous region. Thus, the modal developed will only help to have a basic understanding, but not to select the best alternative, for which the Multi Criteria Decision Making (MCDM) techniques have to be applied to get the priority weights of the criteria. In the next stage, this study proposes an analytical approach for the selection of integrated or 7PL service providers. A systematic approach using AHP has been applied for 7PL service provider selection. The results show that the modal has the capability to be flexible and be applied in different types of industries to choose the 7PL service provider. Each modal is capable of offering a final priority weight for every alternative considered for the final selection at the final hierarchy level. Thus, the best option may be selected using this priority.

References

1. Altinoz, C. (2008). "Supplier selection for industry: a fuzzy rule-based scoring approach with a focus on usability". *International Journal of Integrated Supply Management,* 4(3), 303-321.
2. Esposito, E.., & Passaro, R. (2009). "The evolution of supply chain relationships: An interpretative framework based on the Italian inter-industry experience". *Journal of Purchasing and Supply Management*, 15(2), 114-126.
3. Pohekar, S. D., and Ramachandran, M., (2004), "Application of Multi-CriteriaDecision Making to Sustainable Energy Planning", A Review Renewable and Sustainable Energy Reviews, 8, 365-381.
4. Saaty, T. L., (1980). The Analytical Hierarchy Process, Mc Graw Hill, New York.
5. Saaty, T. L., (1994), Fundamentals of Decision Making and Priority Theory with the Analytical Hierarchy Process, RWS Publications, Pittsburgh.
6. Chang, D. Y., (1992), "Extent Analysis and Synthetic Decision", Optimization Techniques and Applications, World Scientific, Singapore, 1, 352.
7. Cheng, C. H., (1996), "Evaluating Naval Tactical Missile Systems by AHP Based on The Grade Value of Membership Function", European Journal of Operational Research, 96, 343-350.
8. Cheng, C. H., Yang, K. L., and Hwang, C. L., (1999), "Evaluating Attack Helicopters by AHP Based on Linguistic Variable Weight", European Journal of Operational Research, 116, 423-435.
9. Triantaphyllou, E., and Mann, S. H., (1995), "Using the Analytic Hierarchy Process for Decision Making in Engineering Applications: Some Challenges", International Journal of Industrial Engineering: Applications and Practice, 2(1), 35-44.
10. Wabalickis, R. N., (1988), "Justification of FMS with The Analytic Hierarchy process", Journal of Manufacturing Systems, 17, 175-182.