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AHP Based Agile Supply Chains

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Abstract*-- Selection of suppliers and distributors are vital and lays the foundation for supply chain operation. It is an important aspect to choose the best supplier and distributor for effective supply chains. This paper aims to present an analytic hierarchy decision-making approach to deal with the supplier and distributor selection problems in supply chain systems. In recent years, determinations of suitable suppliers and distributors in the supply chains have become a key strategic consideration. However, the nature of these decisions usually is complex and unstructured. Especially, some decision-making data is undefined, vague and fuzzy. In this paper, theoretic values are used to assess weights for selection of supplier and distributor. This paper describes AHP (analytic hierarchy process) used to determine the weighing of subjective judgments.

***Index Terms*—Agile supply chain, AHP, supply chain.**

I. INTRODUCTION

In today's competitive business environments, successfully producing and selling high- quality, low-cost products without considering a satisfactory set of suppliers and distributors is extremely difficult. One extremely important consideration for most enterprises is where to source products, where to sale a product and which supplier &distributor to select. Building an effective supply chain is crucial to success. Selecting the most appropriate suppliers and distributor is an important strategic management decision that can impact all areas of an organization. Supplier and distributor selection is integral to supply chain management. The analytic hierarchic process (AHP) is a relatively new approach well suited to selection process. AHP can be utilized to identify both the importance of weights for criteria and the relative ranking of potential suppliers and distributors. The strength of the method lies in its ability to accommodate judgment factors. This study first provides evidence the procedures for the selection process. Second, this study identifies the suitability of the AHP to assist during decision making and resolve the selection problem.

II. LITERATURE REVIEW

Several methods have been proposed for solving the supplier selection problem such as vendor profile analysis (VPA), multi-objective programming (MOP), data envelopment analysis (DEA) and analytic hierarchy process (AHP) (Chan and Kumar, 2007). Evaluation and ranking of potential suppliers involves both tangible and intangible criteria. This is because overall assessment of suppliers should not only consider quantitative performance data but also some other criteria that are critical for successful partnerships and are not directly quantifiable, e.g. trust and commitment (Mohr and Spekman, 1996).Therefore, the AHP method developed by Saaty (1980) is a useful method to select suppliers as it deals with both types of criteria. In addition, AHP aims at integrating different measures into a single overall score for ranking decision alternatives (Rangone, 1996).The AHP method has been previously used for supplier selection under a wide variety of applications(Perçin, 2006). Ghodsypour and O'Brien (1998) present an integrated AHP and linear programming method for choosing the best suppliers and placing the optimum order quantities among them. Masella and Rangone (2000) propose four different vendor selection systems (VSSs) depending on the time frame (short-term versus long-term) and the content (logistic versus strategic) of the co-operative customer/supplier relationships using an AHP framework. Akarte, Surendra, Ravi, and Rangaraj (2001) propose an AHP model for casting supplier assessment based on four groups of criteria: product development capability, manufacturing capability, quality capability, and cost and delivery. Al-Harbi (2001) applied AHP in the field of project management to select the best contractor to perform the project based on six criteria: experience, financial stability, quality performance, manpower resources, equipment resources, and current workload. Muralidharan, Anantharaman, and Deshmukh (2002) develop a multi criteria group decision making model for supplier ranking based on AHP by combining group member's preferences into one consensus ranking. The criteria used to rate suppliers are quality, delivery, price, and technical capability, financial position, past performance attitude, facilities, flexibility and service. Huan, Sheoran, and Wang (2002) propose an AHP model to structure SCOR (supply chain operations reference) model metrics to evaluate overall supplier efficiency. Kahraman, Cebici, and Ulukan (2003) present a multi-criteria supplier selection procedure using fuzzy AHP. The first level criteria used to compare suppliers involve: supplier, product and service criteria. Chan and Kumar (2007) propose a fuzzy-AHP approach to select global suppliers according to five criteria: cost, quality, service performance, supplier profile and risk factor.

III. SUPPLY CHAIN MANAGEMENT

Supply chain management thoughts had been embodied by the "Quick Response (QR)" of U.S. textile and clothing industry in the middle of twentieth century. Supply chain is the network structure formed by upstream and downstream enterprises providing products and services to end users during the process of production and circulation. SCM (supply chain management) gradually becomes a kind of advanced management modes with good perspectives- It systematically regards core enterprise and upstream and downstream enterprises as an integrated supplier, effectively integrates and manages all activities related to production so as to adapt to the development of enterprises and cooperation among enterprises. SCM refers to a set of methods for

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effectively integrating suppliers, manufacturers, producers, dealers and retailers to produce merchandises to minimize system cost under the precondition of ensuring service level and delivering merchandises of proper quantities to rig-ht places in appropriate time. Figure 1 is shown in Appendix.

IV.AGILE SUPPLY CHAIN

The dynamic alliance combine the virtualization of the cooperation from among enterprises with the operation process agility, it arises at the historic moment in the modern enterprise's intense competition. The dynamic alliance occurs; it entrusts with the new content of supply chain management, unifies though of the dynamic alliance and supply chain, and produces the concept agile supply chain. Agile supply chain to integrate the thought of the dynamic alliance in the traditional supply chain foundation, develops the scope of supply chain to the whole world broadly, emphasizes the information and the automation of the supply and sale link, attaches the full importance to the information of supplier and seller demand, simultaneously also emphasizes the function of the leading enterprise. The characteristic which agile supply chains distinguish from the general supply chain system: the agile supply chain is able to carry on restructuring and the adjustment according to the formation and the disintegration (enterprise reorganizes) of the dynamic alliance, thus fast makes the response to the market demand. The agile supply chain requests to promote enterprise's union through the supply chain management and then enhances the enterprise agility.

V.METHODOLOGY

Problem of selection of supplier and distributor has been dealt with by using questionnaire based study. A structured questionnaire was framed and all the criteria are rated by the professional of various fields. The framework adopted for this study is as shown in figure1. Supplier selection approach is like figure 2 Enterprises analyze market condition first. Then they ascertain supplier target that can be selected. Supplier selection guide line is made next. Enterprise evaluates and selects excellent supplier according to supplier target and selection guideline. At last the supply chain cooperation relation is established between enterprise and supplier to actualize working together. The supplier's evaluation and selection information can also feedback market, which promotes suppliers to improve themselves. When enterprise and supplier cooperate, enterprise can optimize supplier evaluation guideline and make implement experience being reused in market. In supplier selection, enterprise must determine every node's begin time. Every node is a dynamic procedure to improve business. Figure 2 is shown in Appendix.

VI.DISTRIBUTOR SELECTION APPROACH

At present, the global research for the distribution mainly concentrates on the two aspects: one is the research on location problem solved by different methods (The Fuzzy Synthetic. Evaluation, The Delphi Method and Genetic Algorithm, etc); the other is about the performance evaluation of distribution for the distribution centre. The distribution modes in this paper are divided into two parts which are direct distribution and joint distribution. By direct distribution the frozen food is to be delivered from the suppliers to the demanders directly; by joint distribution, the different products should be sent to the distribution centre at first and delivered to different demanders after the process of goods collections in the centre. The example for distribution modes in case a food industry is shown with figure3.

VII. ANALYTIC HIERARCHY PROCESS AS A TOOL

The foundation of the Analytic Hierarchy Process (AHP) is a set of axioms that carefully delimits the scope of the problem environment (Saaty 1986). It is based on the well-defined mathematical structure of consistent matrices and their associated eigenvector's ability to generate true or approximate weights, Merkin, (1979); Saaty (1980, 1994).

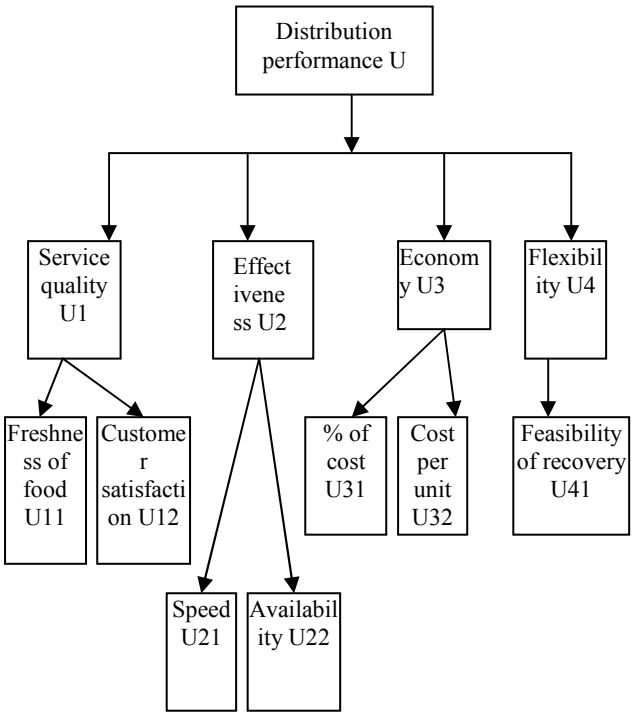

Fig.3. Distribution approach

The AHP methodology compares criteria, or alternatives with respect to a criterion, in a natural, pair wise mode. To do so, the AHP uses a fundamental scale of absolute numbers that has been proven in practice and validated by physical and decision problem experiments. The fundamental scale has been shown to be a scale that captures individual preferences with respect to quantitative and qualitative attributes just as well or better than other scales (Saaty 1980, 1994). It converts individual preferences into ratio scale weights that can be combined into a linear additive weight for each alternative. The resultant can be used to compare and rank the alternatives and, hence, assist the decision maker in making a choice. In this study, all the criteria have been rated from 1 to 9 versus all other criteria as well as versus small scale, medium scale and large scale industries, accordingly as stated in the Table. 1 (Crowe et al., 1998; Saaty, 2000; Hafeez et al., 2002).Based on the ratings obtained through the questionnaire, matrices

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are formed and the priorities are synthesized using the methodology of AHP.

VIII. APPLYING AHP INTO SUPPLIER AND DISTRIBUTOR SELECTION

The AHP decomposes a complex problem into a hierarchy, in which each level has particular characteristics. These elements, in turn, are further deconstructed into sub elements, thereby developing a hierarchical representation of the problem until at the lowest level. Generally, AHP has the following seven steps.

1. Define an unstructured problem and determine its goal.
2. Structure the hierarchy from the top (objectives from a decision-makers viewpoint) through intermediate levels (criteria on which subsequent levels depend) to the lowest level, which typically contains a list of alternatives.
3. Employ a pair-wise comparison approach. Saaty (2001) developed the fundamental scale for pair-wise comparisons. The pair-wise comparison matrix A, in which the element a_{ij} of the matrix is the relative importance of the i^{th} factor with respect to the j^{th} factor, could be calculated as

$$A=[a_{ij}]=\begin{bmatrix} 1 & a_{12} & \cdots & a_{1n} \\ 1/a_{12} & 1 & \cdots & a_{2n} \\ \vdots & \vdots & \cdots & \vdots \\ 1/a_{1n} & 1/a_{2n} & \cdots & 1 \end{bmatrix} \quad \text{..... (1)}$$

There are $n(n-1)$ /judgments require developing the set of matrices in step 3. Reciprocals are automatically assigned to each pair-wise comparison, where n is the matrix size.

4. Hierarchical synthesis is now utilized to weight the eigenvectors according to weights of criteria. The sum is for all weighted eigenvectors corresponding to those in the next lower hierarchy level.
5. Having made all pair-wise comparisons, consistency is identified by using the Eigen value $\lambda \max$, to calculate the consistency index. Saaty (1990) proposed that the largest Eigen value, $\lambda \max$, will be

$$\lambda \max = \sum_{j=1}^{n} a_{ij} \frac{W_j}{W_i} \qquad (2)$$

Where $\lambda \max$ is the principal or largest Eigen value of positive real values in a judgment matrix; Wj is the weight of jth factor W_i is the weight of i^{th} factor.

6. Consistency test. Each pair-wise comparison contains numerous decision elements for the consistency index (CI), which measures the entire consistency judgment for each comparison matrix and the hierarchy structure. Saaty (1990) utilized the CI and consistency ration (CR) to assess the consistency of the comparison matrix. The CI and CR are defined as

$$\text{CI}=\frac{\lambda \max - n}{n-1} \qquad (3)$$

Where n is the matrix size. $\text{CR}=\frac{\text{CI}}{\text{RI}}$ (4)

Where the judgment consistency can be checked by taking the CR of CI with the appropriate value Table 1.

Table 1. Average random consistency (RI)

Size of matrix	1,2	3	4	5	6	7	8	9	10
Random consistency	0	0.58	0.9	1.12	1.24	1.32	1.41	1.45	1.49

The CR is acceptable if it does not exceed 0.10. The CR is > 0.10, the judgment matrix is inconsistent. To acquire a consistent matrix, judgments should be reviewed and improved. In the constantly fluctuating and extremely competitive electronics industry, a company cannot survive without comprehensive supplier identification and evaluation, an e-supply chain and ability to leverage informational advantages to enhance performance. Once a decision is reached for an outsourced product, an electronics firm must identify and frequently evaluate external sources. Construction of the hierarchy is the first step in the problem-solving process. The goal of an AHP decision is to select the best supplier during the first level. Costs, quality, technology, and delivery are the evaluation criteria during the second level of the hierarchy. The third level of the hierarchy shows these primary evaluation criteria based on their criterion dimensions. For instance, the cost criterion depends upon the dimensions of capital investment, material cost, operation cost, and transportation cost. Similarly, the quality criterion is linked to product quality, delivery quality and service quality; the technology criterion is linked product design, process, innovation ability and informational technology; the delivery criterion is linked with timeliness, accuracy and emergency order service. The last level of the hierarchy displays alternative suppliers and distributors A, B, and C. Priorities are established via interviews of, or questionnaires filled out by, purchase managers and sales managers at firms. Table 2 is shown in Appendix.

IX. CONCLUSION

Supplier and distributor selection is an extremely important decision for buyers and seller's respectively. The AHP is an appropriate approach that is well suited to the selection problem. By interviewing and surveying purchase and sales managers of firms, 7 criteria were identified. The process of selection was classified under four labels—cost, quality, delivery, and technology. This proposed tooling can assist managers in making supplier and distributor selection decisions rapidly.

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APPENDIX

Fig. 1: Framework of the study

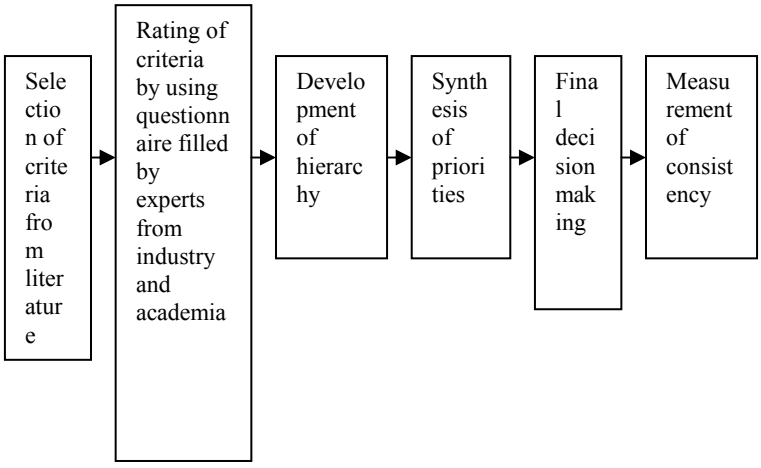
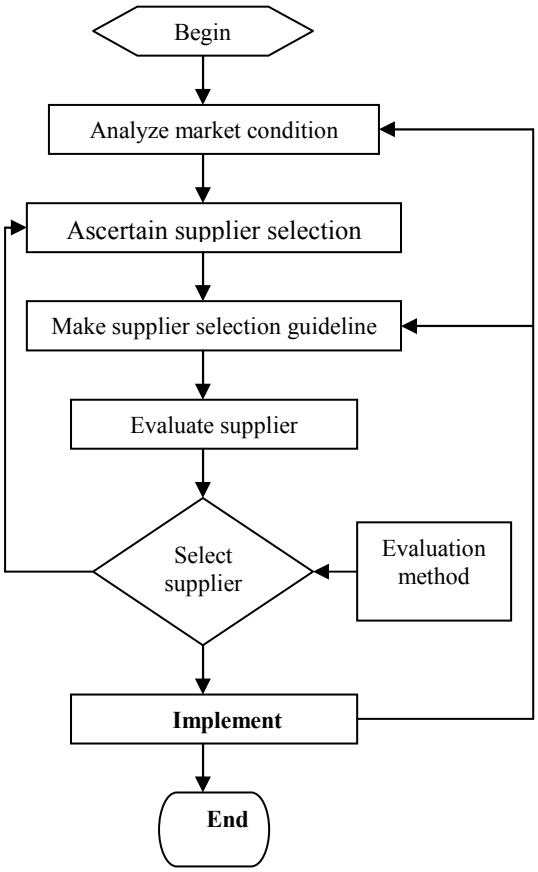


Fig.2 Supplier selection approach



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S.No.	Preference weights/ level of importance	Definition	Explanation
1	1	Equally prefe-rred	Two activities contribute equally to the objective
2	3	Moderately preferred	Experience and judgment slightly favor one activity over another
3	5	Strongly preferred	Experience and judgment strongly or essentially favor one activity over another
4	7	Very strongly preferred	An activity is strongly favored over another and its dominance demonstrated in practice
5	9	Extremely preferred	The evidence favoring one activity over another is of the highest degree possible of affirmation
6	2,4,6,8	Intermediates values	Used to represent compromise between the preferences listed above
7	Reciprocals	Reciprocals for inverse comparison	

Table 2. AHP Approach