The Study on Manufacturing Suppliers Performance Evaluation and Choice Model

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Abstract. Based on analyzing the present fact of domestic and international vendor performance evaluation, Based on the construction of index system for manufacturing supplier ability evaluation and analysis, a new method is presented in this paper, which apply the principal component, the fisher method and K-NN Classifiers method of multivariate statistical analysis. The paper investigated supplier’s choice and supply chain design on the basis of performance evaluation by means of methods of multiplicity statistics comprehensive assessment and goal programming. Finally, the model is approved by a case provided which is practical and effective. The result shows that the model could reflect the capabilities of the supplier objectively and fairly and achieve an effective evaluation on supplier performance and which plays a role of illumination for supply chain design.

Introduction

With the rapid development of knowledge economy, and customer gradually increasing expectations, the competition among enterprises are gradually entering supply chain competition. In the market competition of global economy integration big and complete enterprise is disintegrating gradually, the relation among enterprises present the obvious network tendency day by day, supply chain management (SCM) obtain universal application in the Manufacturing enterprises, becomes one kind of new management pattern[1] In the supply chain management, the thing that carrying on the reasonable appraisal and the choice to the manufacturing supplier, would get supply chain cost reduction, response speed acceleration and efficiency enhancement, as well as enhancement of product and service quality, then satisfy customer requirement[2].

Manufacturing supplier’s achievements evaluation and choice is one of important contents in supply chain design. For our country SCM is being at the start stage, further research is not enough to its theory and method and the content of choosing and evaluating suppliers to be less. Now, the problem has been further studied by many literatures. The domestic and foreign literature have conducted thorough research from many aspects to the supplier evaluation and the choice research question, theory and method, proposed different assessment method [3]-[4].These literature mainly concentrate on the strategy level of supply chain design and the performance appraisal, and which result only plays certain guiding role for the business management, without being one kind of policy-making tool truly. Although the quantitative research have already carried out deeply, but the choice of manufacturing suppliers most is depending on the experience, and lacking the scientifically rational appraisal system and method. Many research, which isn’t based on supply chain foundation, couldn’t adapt the manufacturing supplier appraisal under the supply chain environment [5]. So the study of manufacturing suppliers evaluation and choice own theory and practical significance.

Supply Chain Supplier Evaluation Model and Calculation Process

The Principle of Analysis of Principal Component

The processes of principle of analysis of the principal component are as follows:
1. Date standardization and Achieving the Relevant Quotienty Matrix R though Standardized Date
2. Relevant Quotienty Matrix Character $\lambda$ and Eigenvector L

229
Ask the characteristic value of the matrix of the coefficient correlation \( \lambda_i \) (\( i = 1, 2, \ldots, p \)), write and do \( \lambda_1 \geq \lambda_2 \geq \ldots \lambda_i \geq \lambda_p \geq 0 \), the corresponding characteristic vector quantity tried to get at the same time is \( \beta_i = (\beta_{1i}, \beta_{2i}, \ldots, \beta_{pi})^T \), 1 = 1, 2, \ldots, p

Calculating the Principal Component Score Cost, the score of the i sample in p principal composition directions is \( Z_{i1}, Z_{i2}, \ldots, Z_{ip} \)

The principal component of the i sample, \( F_i = \sum_{j=1}^{p} f_j \times Z_{ij} \) (i = 1, 2, \ldots, n) \[6\].

The Fisher Theory

The processes of the best division theory suppose the ordered sample are X (1), X (2), \ldots, X(N), \( X(i)m \) are vectors

Defined Diameter, With D (i, j) express the diameter of this kind, the commonly used diameter is

\[ D(i, j) = \sum_{i=t}^{N} (X_{it} - \bar{X}_i) \times (X_{jt} - \bar{X}_j) \]

The Loss Function of Defined Classify, The loss function of defining this kind of classification is \( L[b(n, k)] = \sum_{i=1}^{n} D(i, j, i, j, n - 1) \) when \( n, k \) are stable, \( L[b(n, k)] \) small to show all kinds of square and little from difference, it is rational to classify. So should look for a kind of method \( b(n, k) \), enable separating and losing function L to reach minimum. Write P (n, k) make (3) Reach extremely small classification.

Detrude Formula, The most central part of fisher algorithm is to utilize two recurrence formulae. Two type indicate want it if letting, have n pieces of sample divided into k the optimum to cut apart, should set up here on the basis of cutting apart \( j - 1 \) samples into k-1 kind optimum (j = 2, 3, \ldots, n).

Finding the Answer of Best Answer, If classify count k (1<k<n) is known, ask classification means P (n, k), make it lose the function meaning to assign minimum. In a word, in order to ask solving optimum, mainly calculate \{D (i, j); 1 \leq i<j \leq n\} and \{L[P (i, j)]\}, 1 \leq i \leq n, i \leq j \leq n \[7\].

K-Nearest Neighbor

The basic idea of k-Nearest Neighbor is that supposing The number category is c which conclude w1, w2, w3,\ldots wc sample pools and each category has sample marked as Ni, i=1, 2,\ldots, c. Supposing the sample has Z indexes, so the indexes of sample can constitute a z-dimensional space, and all the sample points in space of the z-dimensional have the only point with it. For any identifying sample x, it is also put into the z-dimensional feature space, through the construction a distance formula (generally using Europe’s space-distance), we can find k neighbors of the sample. Also Supposing this N samples N1 came from group w1 sample, N2 came from group w2 sample Nc came from group wc sample. If k1,k2,k3\ldots kc are k-neighbors belonging to w1,w2,w3,\ldots,wc sample, we define the judging function as: \( g_j(x) = k_i, i = 1, 2, \ldots, c \). Classification rules is, that \( g_j(x) = \text{max}k_i\), So classification X belong to wj. The Generalized Squared Distance discriminant function of parameters based on the collectivity distribution belonging the abnormal distribution, and the non-parameter judging method needn’t make all kinds of distributions clear, and estimate kinds of probability density, and then the Classification rules are based on it. K-Nearest Neighbor also called “instance-based” or “lazy leaners”. Because it put all the training samples into storage, and does not establish any previous classification model before classification an unknown individual [8]. This method is quite simple to visual interpretation, for unknown samples x, we need compare x and N type’s distance between the sample, and decide x kind according to the nearest distance [9].

The Evaluation Case Analysis of Supply Chain Suppliers Based on Data Mining

Supply Chain Suppliers Index and Data

In order to assess and value automobile logistics, this paper scores and orders the automobile logistics by the following guidelines: transportation cost F1; supply in time, F2, which express a
contract fulfilled punctually, computation by late goods supply quantity; maintenance service F3, which means response day multiply quantity repaired; arrival of goods, qualified parts quantity F4; The number of times of transportation arrival on time F5; the number of times of the supplier bill arrival accurately F6. Through open information, this paper collect eight automobile logistics annual finance data publicized, and then gain eight simple original data. In comprehensive evaluation index system, there be two type of index: (1) positive index, the more value the more practice production. (2) negative index: the more value the less practice production. Negative index: \( x'_i = -x_i \) [10]. 

**The Process of Evaluation and Choice of Supply Chain Suppliers**

This paper using the most authority software SAS, combining cluster analyzing method of multi-statistics analyzed, assesses eight supply chain suppliers firstly. Using U1-U8 to represent eight supply chain suppliers. Using the SAS software to analyze the original collected data. The principal component could eliminate the overlaps of the standard information and could information provided from standard, through mathematical calculation, objectively. In terms of statistics, these variables may exist high relativity, adding the complexity of the analyzing problem. So how about using a few irrelevant integrate variable to indicate the majority information is the important thing, In terms of mathematics, which is also called degradation logical thinking. [11]

![Figure 1. The L[P (n,k)] trend fig as k change.](image)

**Table 1. The classification result of misclassified sample.**

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<tr>
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</table>

* Misclassified observation

The basic principle of multivariable analysis of the principal component, in order to search the information integrality, the table and fig as follows: According to the eigenvalue and its percentages rate, which be shown, may select two of the principal component P1 and P2, that its percentages accumulative total can reach 82.85%, i.e. P1 and P2. The three genes reflect the information number can reach 82.85%. According to the eight manufacturing suppliers scoring in the principal component, judgment and comparison can be conducted on the operation condition in these
enterprise. We can see, the highest score is got by enterprise U8 which stands for the enterprise U8 has the highest comprehensive ability. Followed by, enterprise U3, U6 and so on. The lowest comprehensive ability is U7 and U5. Now since analyzing the comprehensive sequencing situation of the income on the basis of the principal component, and then utilizing fisher to carry on cluster's analysis to the enterprises. If we cannot make sure the K, then we may make out L[P(n, k)] as the figure when k changes. This paper use G PLOT process from SAS to make out L[P(n, k)] ask changes. See fig.1. K was determined by the curve point. From the graph and we can see K = 4, considering practical situation so we conclude that four categories is better. After analyzing the data from samples, we should divide the seven samples into three categories, i.e. K = 4 from the least lost classify function, L[P(8, 4)] = 0.4507(7) which means that the least loss is 0.4507 When classified, we make out the forth category G4=[X7, X8], and then do other six samples. When divided into three categories, we can get the least loss is LP(6, 3) = 0.3902(5), so G3=[X5, X6], and then do other three samples. When divided into two categories, we can get the least loss is LP(4, 2) = 0.3743(2), so G2=[X3, X4], G1=[X1, X2]. So as to get the best classify P(9,4): [X1, X2], [X3, X4],[X5, X6],[X7, X8] which means the enterprises be divided four categories, so the final result is [U8, U3], [U6, U3], [U2, U4] and [U7, U5]. From analysis above, we can see that the enterprises can be classified into four groups, different type means different level and ability. For the new enterprise, for new enterprises, we can judge it by using the k-Nearest Neighbor. The paper will put data-to-treat into data treated by using SAS9.1 and stands for subject. After this, we submit it to discriminate procedure of K-NN for results, and then the judging result is got. The table below (Table1) is the result after analyzing two enterprises, from the judging result of the judging sample, it can be seen that the Num 12 enterprise belongs to G4.

The comprehensive theory basis of the principal component, the fisher method is one of the most important methods in multi-statistics. This paper takes the basics on the system of constructing the manufacturing supplier's valuation standard, and applies the principal component, the fisher and KNN method to assess the automobile logistics vendors. The manufacturing suppliers may carry on synthesis measure by using the performance evaluation model which make use of principle analysis and fisher, which is better to understand enterprise result in the supply chain operation efficiency and the effect, know about manufacturing suppliers performance level, and can make crosswise and the longitudinal comparison, and causes the enterprise to find problem and solve problem. Which not only might understand the enterprise own achievements level, but may also understand the achievements that other enterprise adopted and provides decision-making reference for enterprise.

Suppliers, and applies the principal component and fisher method to assess the supply chain vendors. this method is proved to be reliable and effective in practical application, and The supply chain management and the design have the vital significance to enterprise's survival and the development, supply chain design to raise the enterprise reaction rate, enterprise flexibility enhancement, to reduce costs have the very vital significance. The supply chain design can become the enterprise superintendent decision-making tool truly. But the manufacturing suppliers choice and the performance appraisal management is a precisely indispensable link. This research chooses the best manufacturing suppliers for the Manufacturing enterprises, which have certain inspiration function to decisions-making for enlarging with cooperation scope among close partners and providing the theory basis for supply chain design. So the model might be regarded as one of main foundations reference for decision making.

Summary

The choice of manufacturing supplier is crucial link of supply chain management. In practice and theory. Because the supplier is the logistics initial departure point in the entire supply chain, which is the capital flow start point, simultaneously also the information flow end point, without the supplier to supply goods uninterrupted quality and quantity, punctuality and highly affection, the entire supply chain link enterprises wouldn’t get smooth operation. Therefore, to the evaluation for
supplier is the entire supervisory control system's beginning. This paper makes the construction of the index system for the evaluation and analysis of manufacturing.

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References