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Performance evaluation research on low carbon supply Chain based on DEA-AHP

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ABSTRACT

Supply chain is one of the hottest issue in today's academic research. It changes the traditional mode of competition, making market competition invert from the competition between individual enterprises into the competition between supply chains. Therefore, the supply chain management has a certain expertise and market competitiveness has a cooperative arrangement between enterprises, which is a activity combining optimal and efficient value. Choose of each node of supply chain system follows the principle of combination, offering the most competitive market power of economic resources. It fuses efficiency of the single enterprise to the overall competitiveness of the core competitiveness, which greatly enhances the market competitive advantage through supplementing each other and harmonious communion of the integration of enterprise resource and ability. How to ensure the combination to bring more advantages, how to reduce the conflicts of the joint between the enterprise and how to test this kind of joint in order to achieved better performance, these all need supply chain members to focus on. Therefore, further systematic research on performance evaluation of supply chain and its management have important theoretical and practical significance[1].

KEYWORDS

Performance evaluation research; Supply Chain, DEA, AHP.

INTRODUCTION OF PERFORMANCE EVALUATION OF SUPPLY CHAIN

Performance evaluation refers to make objective and comprehensive judgment on the results and benefits, reflect the present situation, predict the future development prospect of management control system by using certain technical methods, adopting specific index system, on the basis of the unified evaluation standard, according to certain procedures, through the quantitative and qualitative analysis. Performance evaluation is an important part of management control. Performance evaluation and performance management can help enterprises manage resources more effectively, and measure and control objectives. In supply chain management, in order to make the development of the supply chain healthy, comprehensive, scientific analysis and evaluation of operating performance of the supply chain are essential.

Supply Chain

Supply chain is composed of many enterprises or entities of network chain, including three kinds of the flow of resources: logistics, cash flow and information flow. Generally a supply chain includes the following enterprises or entities: suppliers, manufacturers, wholesalers, retailers and final customers, and the logistics, cash flow and information flow between them can be shown in the Figure 1:

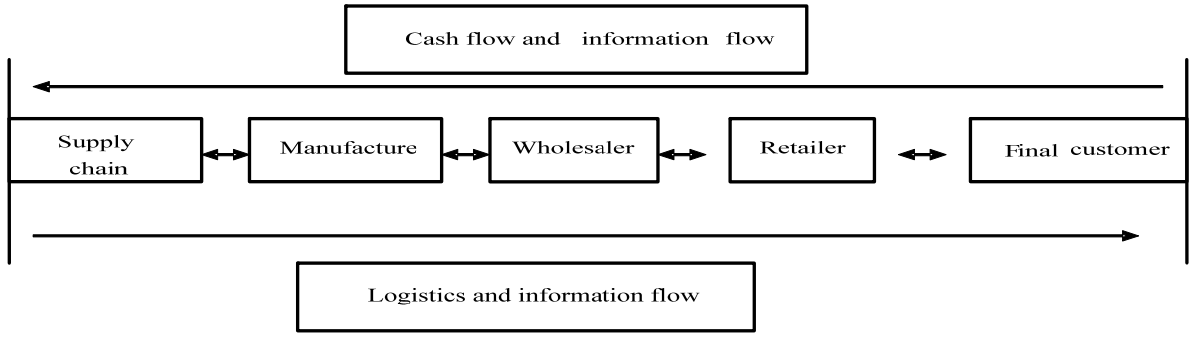

Figure 1 : Supply Chain

Supply chain is a system, is the objective existence of the human production activities and economic activities. Necessities of human life and production are through the initial production of raw materials, spare parts processing, product assembly, distribution and retail process until the final consumption. Both the production and consumption of material here have the physical form and non-physical form such as service products and consumer service. The production, distribution, trade, consumption link all forms a complete supply chain system.

Performance of supply Chain

Engaged in any kind of work should be based on the effect of the activity that is measured and evaluated to determine the performance of the work and its value of existence. According to explanation in the Longman dictionary, performance is the ongoing activities or some kind of activity that has been completed, so the performance can be regarded as a process, also can be regarded as the process to produce results. Expand the explanation to supply chain, you can get: supply chain performance refers to the supply chain operation process and operating results[10]. We can see in the Figure 2 that in a sense, the process of the performance of a supply chain is to increase and create (including all members) value of the supply chain through effective coordination of supply chain members, the activities of the enterprise. From a logistics point of view, manufacturers obtain raw materials from suppliers, process into finished goods, and then packing, and deliver the products to customers by the distributor. Each process is a process of value incensement. From the perspective of information flow, the member enterprises can greatly reduce the operating costs of the supply chain through coordination and information sharing, increase the value of the supply chain. At the same time, they can timely develop products that meet the market demand and provide customer satisfaction services through the timely grasp the change and development trend of the customer requirements,.

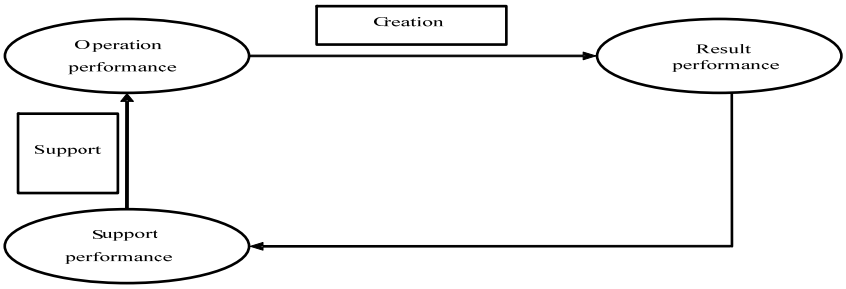

Figure 2 : Performance of supply chain

Performance evaluation of supply chain

According to the basic characteristics and the target of the supply chain operation, the supply chain performance evaluation system should be able to properly reflect the overall operating condition as well as the operation situation between up and down node enterprises of supply chain, rather than evaluate a supplier's operation separately. Evaluating the operation performance of supply chain needs not only to evaluate the node enterprises operating performance, but also to consider the impact of the node enterprises and the entire supply chain[7].

From the following Figure 3 and Figure 4 we can see that supply chain performance evaluation is based on the evaluation of basic business process. And the current single enterprise performance evaluation is based on the evaluation function performance.

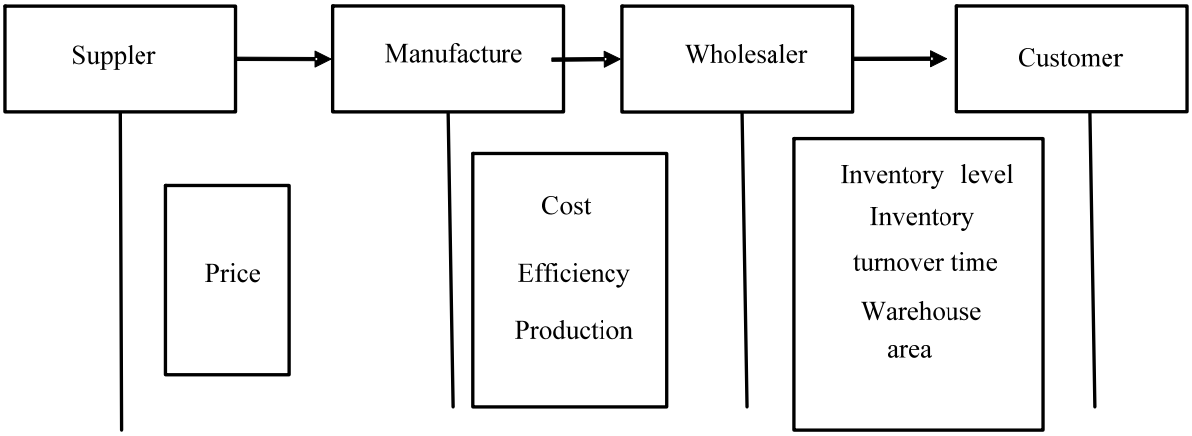

Figure 3 : Performance evaluation based on the functions

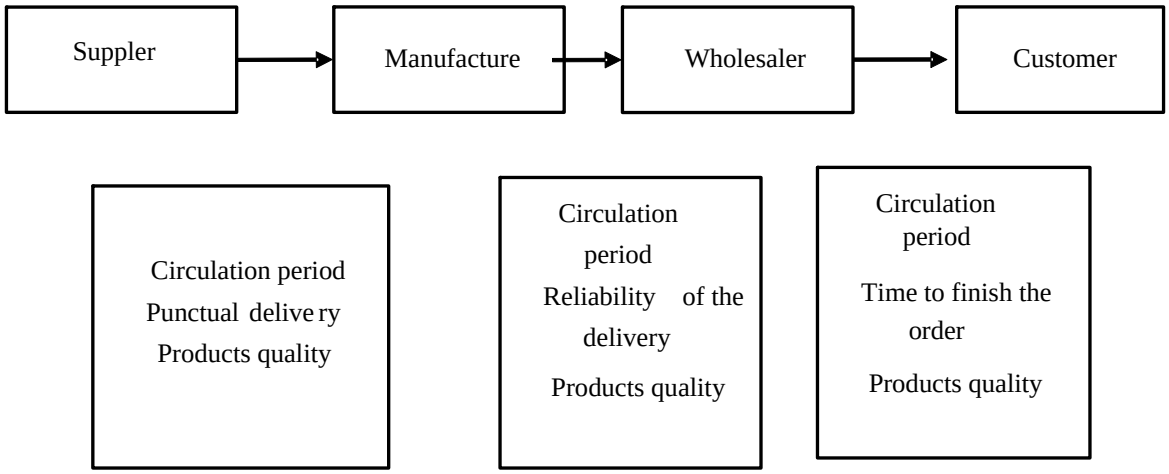

Figure 4 : Performance evaluation based on the process of supply chain

PERFORMANCE EVALUATION OF SUPPLY CHAIN BASED ON DEA (DATA ENVELOPMENT ANALYSIS)

DEA

Data envelopment analysis (DEA) is a kind of efficiency evaluation method put forward by famous operational researchers A. Chames and W.W. Cooper etc. based on the concept of relative efficiency concept. Its basic idea is to put each assessment unit as a decision making unit (DMU). And then many DMUs make up the group to be evaluated. Through the comprehensive analysis of input and output ratio, make sure the effective production frontier, and according to the distance of DMU and efficient production frontier, to determine whether the DMU DEA valid based on the comprehensive analysis of input and output data of each DMU, DEA can draw comprehensive quantitative index, thus each DMU grading queuing, determine the effective DMU, and points out reason and degree that other DMU not valid, and provide information to the competent department. DEA also can judge whether the input size of the each DMU properly, and gives each DMU the right direction and degree of the scale for expansion or narrowing to be better.

Because DEA does not need to estimate parameters in advance, spread the simple concept efficiency of single input and single output to the effectiveness analysis of production of multiple input and multiple output, which has greatly enriched

microeconomic theory of production function and its application technology. At the same time, it avoids the subjective factors and simplifies the operation to reduce error and so on has the superiority of cannot be underestimated[6].

CCR model and C^2 R model based on the DEA method

If we set that there are n units DMU, each DMU has m kinds of input, and s kinds of output, the form can be shown as:

$$X = \begin{bmatrix} V_1 \\ V_2 \\ \cdots \\ V_i \\ \cdots \\ V_m \end{bmatrix} = \begin{bmatrix} x_{11}x_{12}\ldots x_1,\ldots x_{1n} \\ x_{21}x_{22}\ldots x_2,\ldots x_{2n} \\ \cdots \\ x_{i1}x_{i2}\ldots x_i,\ldots x_{in} \\ \cdots \\ x_{m1}x_{m2}\ldots x_m,\ldots x_{mn} \end{bmatrix} \quad (1)$$

$$Y = \begin{bmatrix} \mathrm{u}_1 \\ u_2 \\ \cdots \\ u_i \\ \cdots \\ u_m \end{bmatrix} = \begin{bmatrix} y_{11}y_{12}\ldots y_1,\ldots y_{1n} \\ y_{21}y_{22}\ldots y_2,\ldots y_{2n} \\ \cdots \\ y_{i1}y_{i2}\ldots y_i,\ldots y_{in} \\ \cdots \\ y_{m1}y_{m2}\ldots y_m,\ldots y_{mn} \end{bmatrix} \quad (2)$$

J(j=1, 2, 3… n) respectively corresponds to an input $X=(x_{1j}, x_{2j},\ldots x_{mj})^T$ and an output $Y=(y_{1j}, y_{2j},..y_{mj})^T$. X_{ij} is the input volume in the j decision unit and I type, $x_{ij}>0$;i= 1, 2, 3…m; j=1,2,3,…n; r=1,2,3..s[5].

The traditional CCR model was put forward by Charnes and Cooper in 1978, which was used to evaluate the DMU. The model can be seen in the following:

Min$\{\theta\}$,

$$\text{s.t.} \sum_{i=1}^{n} X_J \lambda_J \le \theta X_{J01},$$

$$\sum_{i=1}^{n} X_J \lambda_J \ge \theta X_{J01},$$

$\lambda \ge 0, \theta$ is free. **(3)**

C^2 R model refers to that if there are n departments or companies, and then n is the DMU, and each DMU has m kinds of input and p kinds of output, and are represented in different economic standard. So the multiple input and multiple output evaluation system consisted by n DMU is made up. The C^2 R linear model is[3]:

$$(\mathrm{p}) \begin{cases} \max V_p = \mu^T y_0 \\ s.t. \varpi^T x_i - \mu^T y_i \ge 0, (1 \le j \le n) \\ \varpi^T x_0 = 1 \\ \varpi \ge 0, \mu \ge 0 \end{cases} \quad (4)$$

PERFORMANCE EVALUATION OF SUPPLY CHAIN BASED ON AHP(ANALYSIS HIERARCHY PROCESS)

Analytic hierarchy process (AHP) is brought up by a famous American operations researcher, Thomes L. Saaty in the early 1970s which is a hierarchical weighted decision analysis method. This method decomposes the elements related to the decision into several levels such as target, the effect, and the indexes. And on the basis of decomposition make qualitative

and quantitative analysis, by using less quantitative information to make decision of mathematical thinking mathematization, and then provides easy decisions for multiple objectives, guidelines, or no structural characteristics of complicated decision-making problems.

The basic idea of AHP is to analyze the problem hierarchically; decompose the problem into different factors according to the nature of the problem and to achieve the overall goal. And according to the correlation between these factors and its subordinate relations, assemble factors according to the different level combination, formed a multi-level analysis structure model; at last, the advantages and disadvantages compared to the problem and sorted.

The processes of the AHP are: (1) establish the multistage progressive structure model on the various elements of constitution of a decision problem. (2) Comparing the two elements above the level of the same level as a criterion. According to rating scales to determine the relative important degree and on the basis of the judgment matrix is established. (3) Determine the relative importance of each factor through a certain calculation. (4) Compare advantages and disadvantages and natural merge sort the alternatives through the calculation of comprehensive importance[2].

The model of AHP is in the Figure 5:

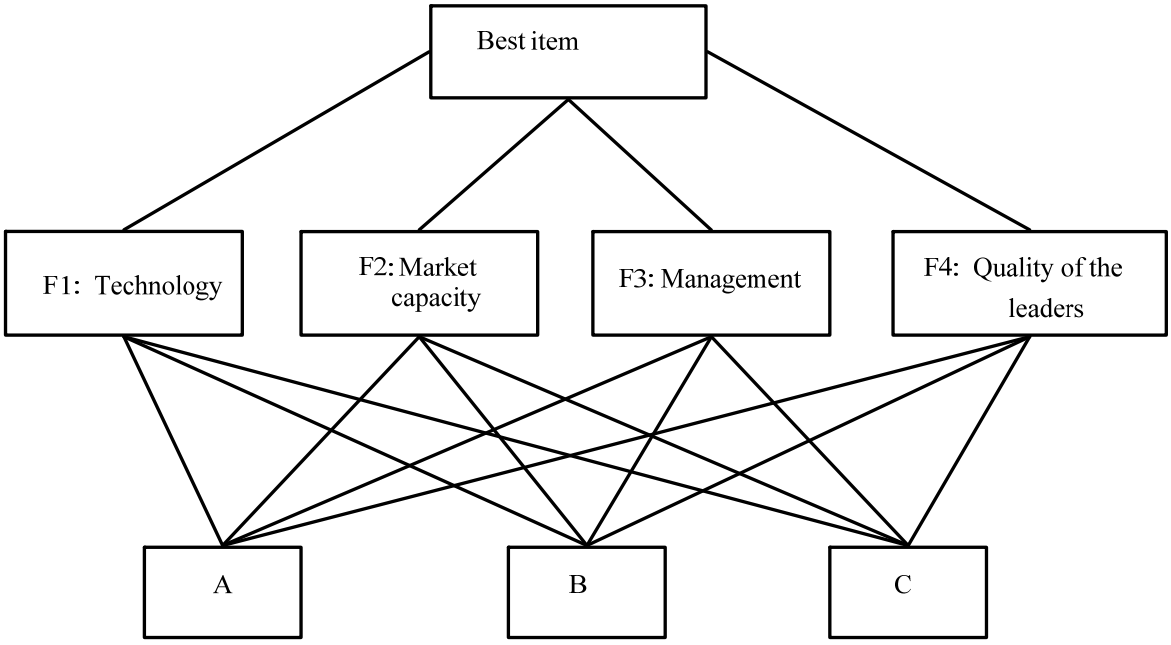

Figure 5 : Model of the AHP

Links in the Figure 5shows the relationship between the lower level elements, the top layer is the target layer, usually only one element; below the target layer is criteria layer, which is the combination of the affected factors, and usually has multilayer meaning criterion layers of time can be established between the sub-layer and the sub-layer from belong to of a certain element in primary layer. Generally, solution layer is set in the bottom of AHP, the elements in the layer is the planning, sorting and selection of objects.

THE EXISTING PROBLEMS AND MEANING OF PERFORMANCE EVALUATION OF SUPPLY CHAIN

1. The definition of supply chain performance evaluation is not systematic, perfect and unified.

This leads to experts and scholars in the process of the selection of supply chain performance indicator system, the main reason for the different emphasis. Although some experts, scholars and research institutions give attention to problems of supply chain performance evaluation, and makes a deep research, but it has not formed a clear and unified definition of supply chain performance, make the further research work, also contributed to the study of chaos.

2. The evaluation index system cannot show the topic.

Topic is the beginning of choice is a research activity, is the focus of the research objects and research purpose together. In the performance evaluation, the selected topic needs to pass through the embodiment of the index system for the specific and clear, and then, evaluates index system and activities around and finally gets the result.

3. The traditional enterprise performance evaluation system has been unable to meet the needs of the supply chain performance evaluation

Enterprise performance evaluation index selection has experienced from a single financial index to the comprehensive index of non-financial indicators, the development of the single index to the multidimensional index, mainly the financial indicators of the traditional enterprise performance evaluation can't apply dynamic, complex supply chain performance evaluation.

4. Methods and means of supply chain performance evaluation need deeper research and development.

In evaluation activity, evaluation methods can be divided into two classes: one is the experience method, another is mathematical methods. The advantage of experience method is simple and widely applicable, and the method to the interpretation of the application process is relatively straightforward. Theory of mathematical method has the advantage of solid foundation, can eliminate the interference of man-made factors such as correctly application and can greatly improve the evaluation of objective impartiality.

In the global economic integration and fierce competition in the market, new products spring up with shorter product life and rapid growth in the number of products. Requirements of customer service and product quality are higher and higher. In order to meet customer demands, improving market share, reducing operating costs to obtain good economic profit and supply chain management thus arises at the historic moment are necessary. So in the supply chain management, there's big difference in the current management mod. In the operation of the enterprise, there are many different analysis ways on the effect evaluation. Current enterprise performance evaluation mainly on the individual enterprises, and supply chain performance evaluation should be able to properly reflect the overall operating condition as well as the up and down between the node enterprises of supply chain operations, rather than in isolation evaluation one supplier or retailer's operations.

SUMMARY

Supply chain is produced under the fierce global competition. Cooperation between the members of the supply chain is to win a greater competitive advantage. Its appearance has changed the traditional mode of competition and market competition, from the competition between individual enterprises into the competition between supply chains. Therefore the supply chain management is to have a certain expertise and market competitiveness of a cooperative arrangement between enterprises, is a set of activities with optimal and efficient value co-creation.

REFERENCES

[1] A.Gunasekaranan, C.Patel, E.Ronald, Mc Gaughey; A framework for supply chain Performance measurement[J], International Journal of Production Economics, 126-135 **(2004)**.

[2] B.M.Beamon; Supply Chain design and analysis, models and methods[J], International Journal of Production Economics, **55**, 281-294 **(1998)**.

[3] W.W.Cooper, Wei Quanling, G.Yu; Using displaced cone representation in DEA models for non-dominated solutions in multi-objective programming[J], Systems Science and Mathematical Sciences, **l0(1)**, 4l-49 **(l997)**.

[4] Chen Meijuan, Chen Guohong; Research and application of DEA[j], Engineering Science, **5(6)**, 88-95 **(2003)**.

[5] S.Croom, P,Romano, M.Giannakis; Supply Chain management, An analytical framework for critical literature review[J], European Journal of Purchasing & Supply Management, **6**, 67-83 **(2000)**.

[6] Liu Chungui, Guo Zhongxing; Research on performance evaluation of low-carbon supply Chain based on data envelopment analysis[J], Science and Technology Management Research, **9**, 96 **(2012)**.

[7] E.H.Sabri, B.M.Beamon; A multi-objective approach to simultaneous strategic and operational planning in supply Chain design[J], Omega, **28**, 581-598 **(2000)**.

[8] C.Stephen, Graves, B.David, Kletter, B.William, Hetzel; A dynamic model for requirements planning with application to supply Chain optimization[J], Operation Research, **3**, 35-49 **(1998)**.

[9] M.Srinivasan, Y.B.Moon; A comprehensive clustering algorithm for strategic analysis of supply Chain networks[J], Computers & Industrial Engineering, **36**, 615-633 **(1996)**.

[10] C.Stephen, Graves, B.David, Kletter, B.William, Hetzel; A dynamic model for requirements planning with application to supply Chain optimization[J], Operation Research, **3**, 35-49 **(1998)**.

[11] Zhang Zhongbin, Guo Jinyu, Sun Qingyun; Study and application of analysis hierarchy process[J], China Safety Science Journal, **18(5)**, 148-153 **(2008)**.