THE APPLICATION RESEARCH ON WUHAN IRON AND STEEL CORPORATION SUSTAINABLE DEVELOPMENT DECISION-MAKING IN LOW-CARBON ECONOMY WITH ANP

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ABSTRACT

With the concept "low carbon economy" is rising, the problem of carbon dioxide emissions in Chinese Iron and Steel Corporation suddenly becomes hot topic in China. More and more managers pay attention to "low carbon economy" and "green economy". However, how to make the Chinese iron and steel industry towards the "low carbon" transition, this is a major problem to be solved which involves many major impact factors. Meanwhile, decision makers in iron and steel corporation need to give a timely answer at the strategic level.The paper uses ANP to help leaders of Wuhan Iron and Steel Corporation make decisions on sustainable development problems in low-carbon economy.

Keywords: ANP, decision making, Wuhan Iron and Steel Corporation, sustainable development issues.

1. Introduction

Nowadays many managers or decision maker always face the challenging situation of selecting the right solution for a given decision making problem. In order to handle multiple, convicting values, a class of methodologies has developed over the last 60 years called problem structuring methods (PSM), or soft operational research (OR) methods. These methods are characterized as a family of approaches for supporting decisions by groups of a diverse composition within a complex environment to agree a problem focus and make commitments to a series of actions. They are usually applied to unstructured problems or ill-structured problems characterized by multiple actors, multiple perspectives, conflicting interests, and high levels of uncertainty and can often involve models as transitional objects to aid the decision-making process [1].

A scientific decision making process can be recognized by Figure 1[2] .

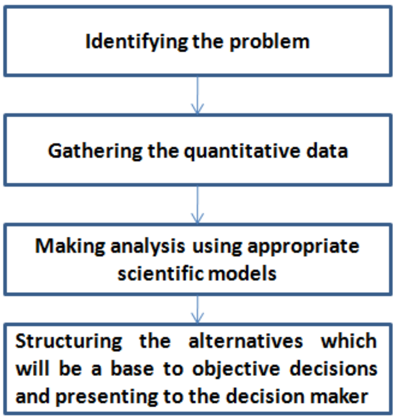

Figure 1. Decision making process

Almost all the decision making methods accept the process above. For example, ANP is a helping tool to make future plans or solve the complicated problems by using qualitative or quantitative data. The paper uses ANP to help leaders of Wuhan Iron and Steel Corporation make decisions on sustainable development problems in low-carbon economy.

2. Literature Review

ANP is one of the most important methods of multicriteria decision aid; (also named MCDA) the multicriteria decision aid method could scientifically select the best decision or optimization under situations characterized for having more than one criterion.

ANP is firstly introduced by Saaty, In 1980, he create the AHP (Analytic Hierarchy Process) method in his book named "The Analytic Hierarchy Process", After that, Thomas L. Saaty developed this issue in his published book named "The Analytic Network Process".

AHP and ANP are both the appropriate methods for solving the decision and evaluation problems, but there are something different. Saaty suggested the usage of AHP to solve the problem of independence on alternatives or criteria and the usage of ANP to solve the problem of dependence among alternatives or criteria[3].

ANP provides a general framework to deal with decisions without making assumptions about the independence of higher-level elements from lower level elements and about the independence of the elements within a level. In fact ANP uses a network without the need to specify levels as in a hierarchy [4], which could deal with more complicated problems than AHP.

3. Hypotheses/Objectives

There are many factors for Wuhan Iron and Steel Corporation's managers to consider about that how to make the low-carbon in enterprise.

We choose 14 factors, such as market demand, coal usage, CO_2 emissions, sustainable development capacity, etc. Then, using the ANP method to compute the result of the factors' influences.

4. Research Design/Methodology

The ANP is composed of four major steps [5]:

Step 1: Model construction and problem structuring: The problem should be stated clearly and be decomposed into a rational system, like a network. This network structure can be obtained by decision-makers through brainstorming or other appropriate methods.

Step 2: Pairwise comparison matrices and priority vectors. In this step alternatives are determined. Selecting the alternatives from the successful ones in their field of activity by using the preliminary elimination will increase the quality of the decision. And the elements are determined.Decision-makers are asked to respond to a series of pairwise comparisons of two elements or two clusters interactions between and within clusters and to be evaluated in terms of their contribution to their particular upper level criteria[6].

In addition, interdependencies among elements of a cluster must also be examined pairwise; the influence of each element on other elements can be represented by an eigenvector. The relative importance values are determined with Saaty's 1–9 scale, where a score of 1 represents equal importance between the two elements and a score of 9 indicates the extreme importance of one element (row cluster in the matrix) compared to the other one (column cluster in the matrix) [7].

A reciprocal value is assigned to the inverse comparison Like with AHP, pairwise comparison in ANP is performed in the framework of a matrix, and a local priority vector can be derived as an estimate of the relative importance associated with the elements (or clusters) being compared by solving the following equation:

Step 3: Supermatrix formation:

To obtain global priorities in a system with interdependent influences, the local priority vectors are entered in the appropriate columns of a matrix. As a result, a supermatrix is actually a partitioned matrix, where each matrix segment represents a relationship between clusters in a system.

$$
\begin{array}{c}
 \\ W = \begin{array}{c} C_1 \\ \vdots \\ C_k \\ \vdots \\ C_n \end{array}
\begin{array}{c} e_{11}\; e_{12} \cdots e_{1m1} \\ e_{k1}\; e_{k2} \cdots e_{k\,mk} \\ e_{n1}\; e_{n2} \cdots e_{n\,mn} \end{array}
\end{array}
\overset{\begin{array}{ccc} C_1 & C_k & C_n \\ e_{11}\, e_{12} \cdots e_{1m1} \cdots & e_{k1}\, e_{k2} \cdots e_{k\,mk} \cdots & e_{n1}\, e_{n2} \cdots e_{n\,mn} \end{array}}{\begin{vmatrix} W_{11} & \cdots & W_{1k} & \cdots & W_{1n} \\ \vdots & & \vdots & \vdots & \vdots \\ W_{k1} & \cdots & W_{kk} & \cdots & W_{kn} \\ \vdots & & & \vdots & \\ W_{n1} & \cdots & W_{nk} & \cdots & W_{nn} \end{vmatrix}}
$$

Figure 2. A standard form for a supermatrix

Generally in this step the supermatrix will be an unweighted one. Because in each column it consists of several eigenvectors which of them sums to one (in a column of a stochastic) and hence the entire column of the matrix may sum to an integer greater than one. The supermatrix needs to be stochastic to derive meaningful limiting priorities. So for this reason to get the weighted supermatrix, firstly the influence of the clusters on each cluster with respect to the control criterion is determined. This yields an eigenvector of influence of the clusters on each cluster. Then the unweighted supermatrix is multiplied by the priority weights from the clusters, which yields the weighted supermatrix.

The limit supermatrix has the same form as the weighted supermatrix, but all the columns of the limit supermatrix are the same.

The final priorities of all elements in the matrix can be obtained by normalizing each cluster of this supermatrix. Additionally, the final priorities can be calculated using matrix operations, especially where the number of elements in the model is relatively few. Matrix operations are used in order to easily convey the steps of the methodology and how the dependencies are worked out.

Step 4: Selection of the best alternatives: If the supermatrix formed in Step 3 covers the whole network, the priority weights of the alternatives can be found in the column of alternatives in the normalized supermatrix. On the other hand, if a supermatrix only comprises clusters that are interrelated, additional calculations must be made to obtain the overall priorities of the alternatives. The alternative with the largest overall priority should be selected, as it is the best alternative as determined by the calculations made using matrix operations.

5. Data/Model Analysis

Figure 3 The ANP network in our case

Table 1 Initial matrix

	14 N	10 J	11 K	12 L	13 M	9 I	4 D	7 G	8 H	3 C	6 F	5 E	2 B	1 A
14 N	0	0	0	0	0	0	0	0	0	0	0	0	0	0
10 J	0.379	0	0	0	0	0	0	0	0	0	0	0	0	0
11 K	0.379	0	0	0	0	0	0	0	0	0	0	0	0	0
12 L	0.242	0	0	0.56	0	0	0	0	0	0	0	0	0	0
13 M	0	0.239	0	0.44	0	0	0	0	0	0	0	0	0	0
9 I	0	0.201	0.302	0	0	0	0	0	0.38	0	0	0	0	0
4 D	0	0.28	0	0	0	0	0	0	0	0	0	0	0	0
7 G	0	0.28	0	0	0	0	0	0	0	0	0	0	0	0
8 H	0	0	0.698	0	0	0	0	0	0	0	0	0	0	0
3 C	0	0	0	0	0	0.745	0	0	0	0	0	0	0	0
6 F	0	0	0	0	0	0.255	0	0	0.395	0	0.62	0	0	0
5 E	0	0	0	0	0	0	0	0	0.225	0	0	0.37	0	0
2 B	0	0	0	0	0	0	0	0	0	0	0.38	0	0	0
1 A	0	0	0	0	0	0	0	0	0	0	0	0.63	0	0

6. Limitations

The weight of the initial matrix is subjective. How to get the valid origin data is a difficult task.

7. Conclusions

Table 2 the final ultimate matrix

	14 N	10 J	11 K	12 L	13 M	9 I	4 D	7 G	8 H	3 C	6 F	5 E	2 B	1 A
14 N	1	0	0	0	0	0	0	0	0	0	0	0	0	0
10 J	**0.379**	1	0	0	0	0	0	0	0	0	0	0	0	0
11 K	**0.379**	0	1	0	0	0	0	0	0	0	0	0	0	0
12 L	**0.55**	0	0	2.2727	0	0	0	0	0	0	0	0	0	0
13 M	**0.33258**	0.239	0	1	1	0	0	0	0	0	0	0	0	0
9 I	**0.29116**	0.201	0.56724	0	0	1	0	0	0.38	0	0	0	0	0
4 D	**0.10612**	0.28	0	0	0	0	1	0	0	0	0	0	0	0
7 G	**0.10612**	0.28	0	0	0	0	0	1	0	0	0	0	0	0
8 H	**0.26454**	0	0.698	0	0	0	0	0	1	0	0	0	0	0
3 C	**0.21692**	0.14975	0.42259	0	0	0.745	0	0	0.2831	1	0	0	0	0
6 F	**0.47037**	0.13488	1.1062	0	0	0.67105	0	0	1.2945	0	2.6316	0	0	0
5 E	**0.09448**	0	0.24929	0	0	0	0	0	0.35714	0	0	1.5873	0	0
2 B	**0.17874**	0.051255	0.42036	0	0	0.255	0	0	0.4919	0	1	0	1	0
1 A	**0.05952**	0	0.15705	0	0	0	0	0	0.225	0	0	1	0	1

A类		B类		C类	
12 L	0.55	8 H	0.26454	5 E	0.09448
6 F	0.47037	3 C	0.21692	1 A	0.05952
11 K	0.379	2 B	0.17874		
1O J	0.379	7 G	0.10612		
13 M	0.33258	4 D	0.10612		
9 I	0.29116				

8. Key References

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