FEASIBILITY ON NEW PRODUCT DEVELOPMENT: Application of the AHP to Decisions on Product Development

Zhengxin LI, Shengye ZANG
The Economic Research Center of Siping Government
Siping, Jilin, P. R. China

Abstract

Using "AHP", this article inquires into relations and actions of various decision-making factors on new product development, puts forward feasible conception of comprehensive survey for product development project, and uses percentage to show the feasible level of new product development. This result has been shaped in technical development and countermeasure study on Siping administrative region non-metallic minerals, Jilin, China.

1. Introduction

During new product development, market requirements, advantage on ability, fitness for use, and technical economy should be comprehensively considered. Meanwhile, others, such as available technology and equipment, raw material, capital, and even forecasted benefit are key factors which will influence decision-making. Among these factors, most of them relate to multicriteria from nature, society, economy and technology. Some of the criteria are quantitative, while others are qualitative. How to take reasonable decisions using these quantitative and qualitative factors has been a multi-solution question. To solve if, the AHP has been applied in our research on the feasibility study of product development.

In the research based on AHP, the hierarchy structure model of the feasibility study has been formed. At the same time, a new concept called C which includes various criteria for feasibility, was developed to indicate the level of the feasibility of product development. The reason why the concept was developed and used is because of the following three principles:

First, in the optimal-contrast consideration of the feasibility on multi-product projects, if the factors are considered one by one, the calculating work is too large.

Second, it is important that different projects which need different technologies and have different uses, the feasibility is directly and clearly stated/

Third, if a visible and clear quantitative indicator for the feasibility is available, the indicator will be helpful to the application of AHP - the scientific method in practice.

2. Model and Calculating Method

The analytic hierarchy model for the feasibility study consists of five layers: target layer C, criteria layer Z, affective-factor layer Y, evaluation layer P, and product-project layer X. Basically, the model can indicate four principles for product-development, ten main affective factors and thirty inter-relations among the factor-evaluations. According to this model, the feasibility of the product can be calculated. The calculating method is as follows:

I. According to AHP basic calculating principles, the factors Y_1, Y_2.....Y_n from target layer, criteria layer, affective-factor layer, calculating affective layer, have corresponding weights, W_{y1}, W_{y2}, ... , W_{yn}.

II. By giving the feasibility value for the factor, in order to show the feasibility by percentage as accepted as usual, and to simplify the calculation when the multi-products projects are compared, the feasibility value, L, must be obtained from the general weight W_{yn}. Generally, L and W_{yn} have the same indications. They mean the influence level of the affective factors on product development.

III. Evaluation of the factors of the product projects. In accordance with the projects layer and factor-evaluation layer, every factor of the project must be evaluated independently.
The feasibility evaluation is a kind of forecasting measure of product development. In the view of the probability and requirement, every factor has its own evaluation value. The factors must be divided into a, b, c grades. Their related value are 5, 3, 1 which are used to show the degree of influence. The value of evaluation is named P. Sometimes P can be 4, or 2.

IV. C - the feasibility degree of product development. As we know from above, L represents the effect of the factors on the feasibility, and P indicates the level of influence of the factors. Thus, L*P means the evaluation of the factors on the product development. Thus, we have:

$$C = \sum_{i=1}^{n} L_i P_i / 100$$

where,

C is the degree of feasibility of product development, n is the total number of factors, L_i is the feasible value of the ith factor, and P_i is the evaluation value of the factor i.

L is obtained from the structure model and the corresponding matrix. P can be definite 1 to 5 according to the particular situation. According to AHP, the study of the feasibility is no longer a judgment and evaluation study. It becomes an easily calculated, quantitative, mathematical one. And so, the application of AHP will be useful and practical for product development and scientific decision-making.

3. Design of Criteria Matrix and Queueing

For any project, the four criteria principles are necessary and important, but these principles have different influences on the development of the product. With socialization of production and the internationalized economy, the position of the principles is like this: requirement of market, benefit, technique available and conditions provided. In fact, since the Chinese economy is a planned commodity economy, the social benefit of products are stressed at first. This is because the development of the product must meet and follow the national general plan. Thus, in China, the order of the principles for product development should be both requirement and benefit first, technique second, and provided conditions third. According to the importance and difference, these principles form the contrasting matrix C-Z, which is corresponding to the target layer. See Table 1.

Table 1. C-Z contrast matrix

C	Z_1	Z_2	Z_3	Z_4	W
Z_1	1	2	2	1	0.3300
Z_2	1/2	1	2	1/2	0.1996
Z_3	1/2	1/2	1	1/2	0.1404
Z_4	1	2	2	1	0.3300

$\lambda max = 4.060765$ C.R.= 0.0225

On the basis of relations between the factors and their corresponding criteria layer, the Z-Y contrast matrices are formed (see Tables 2, 3, 4, and 5.)

Table 2. Z_1 - Y contrast matrix

Z_1	Y_1	Y_2	W
Y_1	1	2	0.6667
Y_2	1/2	1	0.3333

$\lambda max = 2$ C.R. = 0

Table 3. Z_2 - Y contrast matrix

Z_2	Y_3	Y_4	Y_5	W
Y_3	1	3	5	0.6370
Y_4	1/3	1	3	0.2583
Y_5	1/5	1/3	1	0.1047

$\lambda max = 3.038519$ C.R. = 0.0332

Table 4. Z_3 - Y contrast matrix

Z_3	Y_6	Y_7	Y_8	W
Y_6	1	5	2	0.5816
Y_7	1/5	1	1/3	0.1059
Y_8	1/2	3	1	0.3090

$\lambda max = 3.003697$ C.R.= 0.0032

Table 5. Z_4 - Y contrast matrix

Z_4	Y_9	Y_{10}	W
Y_9	1	2	0.6667
Y_{10}	1/2	1	0.3333

$\lambda max = 2$ C.R. = 0

Obviously, as the tables show, the weight W_y, corresponding to the target layer, is available when the criterion and its contrast matrix is correct.

The weights of the factors on the feasibility are shown on Table 6. Judging by the values of the weights, the order of the factors should be Y_1, Y_9, Y_3, Y_2, Y_{10}, Y_6, Y_4, Y_8, Y_5, Y_7. And the sum of the first seven weights is 92.03% of the total. This fact definitely indicates that accurate prediction of the importance, benefit, technology preparation, raw material, and technique advantage and other factors decides the success of the projects. The method generally and briefly shows the contents which are considered in decision-making process, and logical thinking on product development.

Table 6

Z \ C	Z_1	Z_2	Z_3	Z_4	W_y	L
	0.3300	0.1996	0.1404	0.3300		
Y_1	0.6667				0.2200	4.4
Y_2	0.3333				0.1100	2.2
Y_3		0.6370			0.1271	2.6
Y_4		0.2583			0.0516	1.0
Y_5		0.1047			0.0209	0.4
Y_6			0.5816		0.0817	1.6
Y_7			0.1059		0.0154	0.3
Y_8			0.3090		0.0434	0.9
Y_9				0.6667	0.2200	4.4
Y_{10}				0.3333	0.1100	2.2

CR = 0.0273

After analyzing the factors, the results show that the structures of contrast-matrix are reasonable. Given the weights of the factors, the feasibility value L value is obtained, and the projects can been evaluated based on L and P.

4. Results

On the basis of model given above and the calculating method we tested the degree of feasibility of 18 non-metallic ore projects. The results are as follows:

2 projects with $C > 80\%$

14 projects with $60\% \leq C \leq 80\%$.

1 project with $C < 60\%$

1 project with $C < 50\%$.

Overall, there were 16 projects whose C values are more than 60% that have been developed recently.

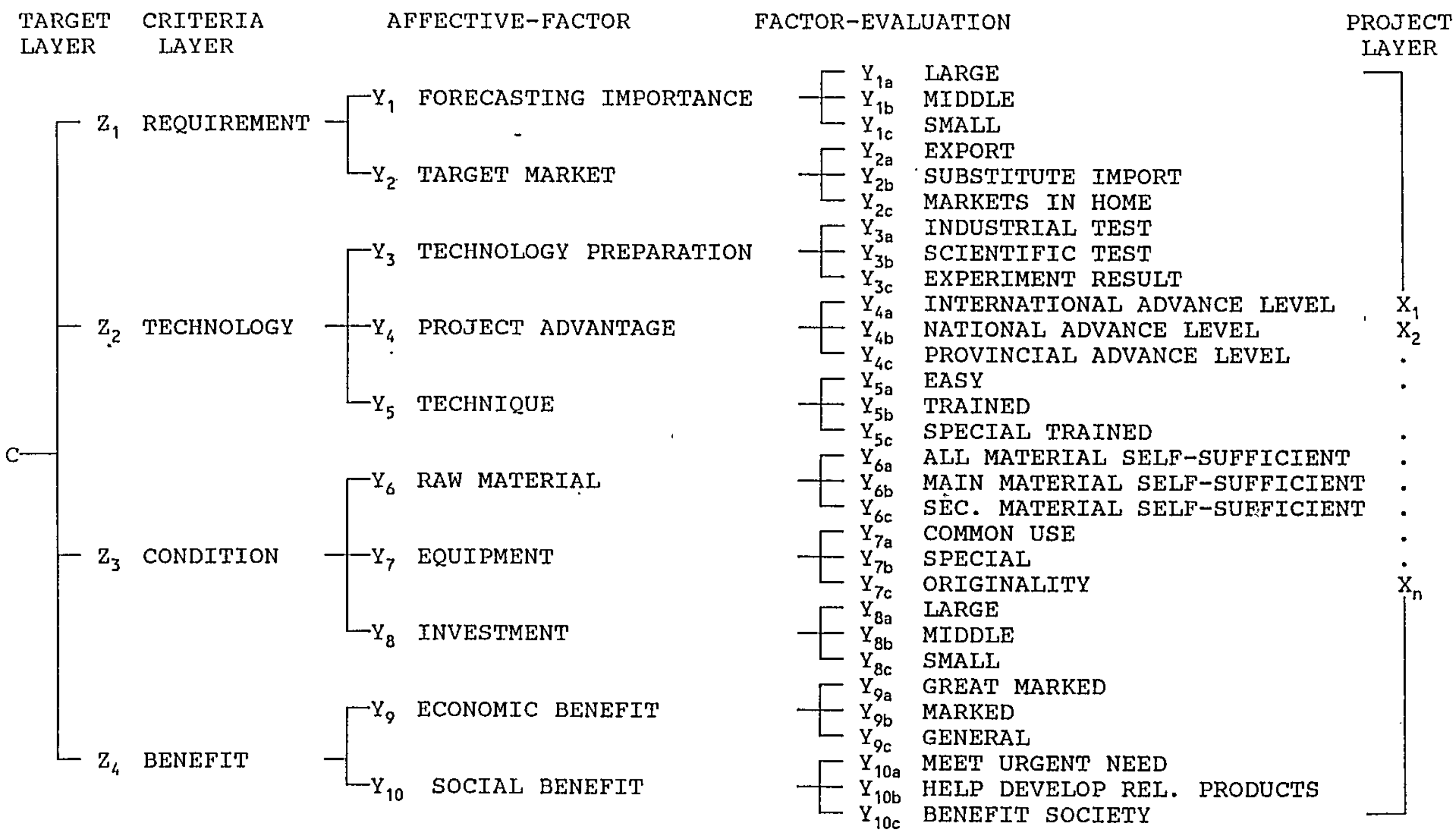
REFERENCES

1. Saaty, T.L., The Analytic Hierarchy Process, McGraw Hill International Book Co., (Chinese) 1988.9.

2. Xu, Shubo, Theory of AHP, Tianjing University Publishing House, 1988.

3. Zhao HuanCheng, AHP---A New Method for Product-Development, Scientific Publishing House, 1986.

4. Li Jichen, Evaluation of Industrial Enterprises' Innovation Projects, Changchun Publishing House, 1990.1.



FEASIBILITY OF NEW PRODUCT DEVELOPMENT