Research of High-Tech Enterprises Evaluation and Decision Support System

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Abstract

Applying to the system engineering, software engineering theory and methods, a system is designed with subjective and objective, qualitative and quantitative evaluation and intelligent decision support. Analytic Hierarchy Process (AHP) makes the weight setting more reasonable. Meanwhile enterprise's comprehensive evaluation model has been constructed by the efficiency coefficient method with multi-objective decision-making. In the system, the expandable decision-making knowledge database was designed in the form of single-tree inference, which can give feasible decision-making suggestions based on different evaluation result.

Keywords: Enterprise Evaluation, DSS, Analytic Hierarchy Process, Multi-Objective Decision-Making, Decision-Making Suggestion

The evaluation system and model aimed to the high-tech enterprise has been established, which can measure and reflect its development. It's useful for decision-makers to realize their situation, advantages, characteristics, shortage comprehensively and practically in a scientific way, and make correct decisions. At the same time, it also explored a new decision approach for high-tech enterprises evaluation and decision-making in the market economy environment.

1. System Analysis and Design

1.1 System Frame Structure

The system is designed based on the following consideration: how high-tech enterprises face to the market problem. And its primacy yardstick is making a correct, reasonable appraise and giving a good improvement suggestion; its starting point is solving practical problems and user-friendly. It's not only using the 'dialogue, model, data' three structural components as framework, but also assimilating the advantages of 'Language System (LS), problem Processing System (PPS), Knowledge Systems (KS)'three components structural from the perspective of practicality. Then a system frame structure has been formed based on six compartments which include human-machine interface, data interface, problem processing system (PPS), database, model base, knowledge base. The system framework is following: Figure 1:

The data that high-tech enterprises needed are sample from the National Science Commission Statistical Databases and Financial Databases, as well as from the enterprise itself.

The relational model applied in terms of database designing, E-R Approach (Entity-Relationship Approach) is used for designing.

1.2 System Workflow

First, users sample some external data as the data source of evaluation system. In the same time, they can input evaluation index date which various enterprises need, then evaluate the enterprises and high-tech, and provide better suggestion and decision-making for decision-makers based on the evaluation results through strategic management base. The sketch of system workflow is following: Figure 2.

2. Confirmation of high-tech enterprises evaluation index

2.1 Layered structure of high-tech enterprises evaluation index

After analyzing the market factor, high-tech standards, economic index and other aspects, as well as selecting in a scientific way, evaluation index can be divided into three categories, which are called the first rank index: high-tech evaluation criterion, marketing, economic efficiency composite index. Corresponding respectively they are followed with the second, third rank index. Based on those, the layered structural evaluation index has been constructed. The entire index parameters are showing in Figure 3.

2.2 Comprehensive evaluation model of the high-tech enterprises

The whole comprehensive evaluation is based on multi-objective decision-making and Analytic Hierarchy Process[1]–[3]. Every second rank index can be seen as a multi-objective decision-making problem.

On the assumption that, including the number of p indexes $f_1(x)$, ..., $f_p(x)$, effectiveness coefficient of the objective function $f_i(x)$ is: $d_j = d_j(f_j(x))$, j=1,2...p; Then account the total efficiency coefficient: $\overline{D} = \left[\sum_{j=1}^{p} a_j d_j\right]$ (weighted); If considering the relative importance between the sub-goal f_j and the overall goal, then give the weight coefficients corresponding with the sub-goal

$$\lambda = \left\{(\lambda_1, \lambda_2, \Lambda\ , \lambda_p) \mid j > 0, j = 1, \Lambda\ , \sum_{j=1}^{p} \lambda_j = 1\right\}$$

Steps of comprehensive evaluation for enterprise:

1) Make a single contrast analysis for the second rank index; list them according to their priorities.

2) Make an order analysis for the major category of criteria:

High-tech evaluation criteria:

$$W_{1(i)} = \beta_1 \overline{d_{1(i)}} + \beta_2 \overline{d_{2(i)}} + \beta_3 \overline{d_{3(i)}} + \beta_4 \overline{d_{4(i)}} + \beta_5 \overline{d_{5(i)}}$$

$$\beta_1 + \beta_2 + \beta_3 + \beta_4 + \beta_5 = 1$$

Marketing:

$$W_{2(i)} = \beta_6 \overline{d_{6(i)}} + \beta_7 \overline{d_{7(i)}} + \beta_8 \overline{d_{8(i)}} + \beta_9 \overline{d_{9(i)}}$$

$$\beta_6 + \beta_7 + \beta_8 + \beta_9 = 1$$

Economic efficiency composite index:

$$W_{3(i)} = \beta_{10} \overline{d_{10(i)}} + \beta_{11} \overline{d_{11(i)}} + \beta_{12} \overline{d_{12(i)}} + \beta_{13} \overline{d_{13(i)}} + \beta_{14} \overline{d_{14(i)}} + \beta_{15} \overline{d_{15(i)}} + \beta_{16} \overline{d_{164(i)}}$$

$$\beta_{10} + \beta_{11} + \beta_{12} + \beta_{13} + \beta_{14} + \beta_{15} + \beta_{16} = 1$$

Expressions mentioned before, the β_j are the corresponding weight coefficients, identified by the Analytic Hierarchy Process (AHP).

3) Comprehensive evaluation of enterprise

First, make a contrast analysis for the $A_{(i)} = \{W_{1(i)}\ W_{2(i)}\ W_{3(i)}\}$

If $A_{(i)} \geq A_{(j)}$ i ≠ j; i, j = 1, 2, …m. It's represented that each first rank index of I business were greater or equal than that of the second index of J business ,this means that the I business is better than J business in all aspects.

In case inexistence of $A_{(i)} \geq A_{(j)}$,then need to carry on the comprehensive evaluation and analysis , comprehensive evaluation model is:

$$A_{(i)} = \lambda_1 W_{1(i)} + \lambda_2 W_{2(i)} + \lambda_3 W_{3(i)}$$

$$\lambda_1 + \lambda_2 + \lambda_3 = 1$$

The comprehensive evaluation function:

$$\begin{aligned} A_{(i)} = {} & \beta_1\lambda_1 \overline{d_{1(i)}} + \beta_2\lambda_1 \overline{d_{2(i)}} + \beta_3\lambda_1 \overline{d_{3(i)}} + \beta_4\lambda_1 \overline{d_{4(i)}} + \beta_5\lambda_1 \overline{d_{5(i)}} \\ & + \beta_6\lambda_2 \overline{d_{6(i)}} + \beta_7\lambda_2 \overline{d_{7(i)}} + \beta_8\lambda_2 \overline{d_{8(i)}} + \beta_9\lambda_2 \overline{d_{9(i)}} \\ & + \beta_{10}\lambda_3 \overline{d_{10(i)}} + \beta_{11}\lambda_3 \overline{d_{11(i)}} + \beta_{12}\lambda_3 \overline{d_{12(i)}} + \beta_{13}\lambda_3 \overline{d_{13(i)}} + \beta_{14}\lambda_3 \overline{d_{14(i)}} + \beta_{15}\lambda_3 \overline{d_{15(i)}} + \beta_{16}\lambda_3 \overline{d_{16(i)}} \end{aligned}$$

$$\begin{aligned} & \beta_1\lambda_1 + \beta_2\lambda_1 + \beta_3\lambda_1 + \beta_4\lambda_1 + \beta_5\lambda_1 + \beta_6\lambda_2 + \beta_7\lambda_2 + \beta_8\lambda_2 \\ & + \beta_9\lambda_2 + \beta_{10}\lambda_3 + \beta_{11}\lambda_3 + \beta_{12}\lambda_3 + \beta_{13}\lambda_3 + \beta_{14}\lambda_3 + \beta_{15}\lambda_3 + \beta_{16}\lambda_3 = 1 \end{aligned}$$

3. Research cases: The high-tech enterprises in Zibo

3.1 Conformation of enterprises evaluation weight

First, take economic efficiency composite index for example, it has seven indexes, so the judgment matrix structured as following:

C	C1	C2	C3	C4	C5	C6	C7
C1	1	1	1	2	3	2	2
C2	1	1	1	1	3	1	1
C3	1	1	1	1	2	1	2
C4	1/2	1	1	1/2	1	1	1
C5	1/3	1/3	1/2	1/2	1	1	1
C6	1/2	1	1	1	1	1	1

Account the product of each row element of M matrix: F=(24,3,4,1,0.0278,0.5,0.25)

Account the number of n power root of F :

$\overline{W} = (1.575, 1.170, 1.219, 1.00, 0.599, 0.906, 0.820)$

Vector normalization, get the eigenvector as following:

$W = (0.216, 0.167, 0.137, 0.082, 0.124, 0.113)$

Largest eigenvector of the judgement matrix is : $\lambda_{\max} = 7.177$

Carrying on the consistency check, then obtains: CI=0.0295, check the form according to module RI=1.32,

Because of the random consistency ratio R=0.0224<0.1 ,so the weight of calculation is satisfied.

3.2 Enterprises Comprehensive Evaluation

Take the YuMin fire-resistant material corporation for example :

1) Constructed weight designing value with AHP method; And the following results are gained by adopting the Efficacy coefficient method to construct the evaluative model:

(1) Calculation results of the high-tech evaluation standard:

Weight: $\beta = (0.18, 0.27, 0.16, 0.24, 0.15)$

Efficacy coefficient: $W_1 = (0.359, 0, 0, 0.415, 1)$

(2) calculation results of the marketing:

Weight : $\beta = (0.254, 0.302, 0.162, 0.281)$

Efficacy coefficient: $W_2 = (0.569, 0.54, 0.473, 0.282)$

(3) Calculation results of the economic efficiency composite index:

Weight : $\beta = (0.216, 0.161, 0.167, 0.137, 0.082, 0.124, 0.113)$

Efficacy coefficient: $W_3 = (1, 1, 0.851, 1, 0.834, 1, 0.908)$

2) Carrying on the comprehensive evaluation of the enterprise:

Using AHP mathod to set the Weight of composite index : $\lambda = (0.149, 0.474, 0.377)$

According to the efficiency coefficient method of multi-objective decision-making, the comprehensive evaluation result of Yumin fire-resistant material corporation is gained: A=0.65.It means that this company pertains to power-oriented enterprises, various indexes in the evaluation system are well-qualified, and the evaluation results consist with the actual situation.

4. Determination of the strategic decision

According to the comprehensive evaluation results, the system can get the relevant business strategic decision-making from knowledge database for reference.

If business is operating badly according to the results, decision-makers need to adopt the jointly competitive strategy. The enterprises should cooperate not only in division labor, but also in financial and marketing. For

example,establishing unification sales group, jointed efforts in developing market, thus helping enhance the competitiveness;

If you can make sure that the enterprise is not in bad operating, but with poor strength and small-scale, then use 'small and fine' strategy. Through centralized power to improve product quality and the degree of specialization, thereby on the way to big and specialization; On the contrary, larger scale enterprises can use diversification operation strategy. On the one hand, the enterprises expand to other areas in the form of sideline businesses to decentralized operation risks; On the other hand, in order to make full use of operation resources, the enterprises can develop to the correlative area in technology, market;

If the enterprise is power-oriented, it may take unique strategy in the technical product itself and its function or in product sales of delivery systems and marketing strategy, which can reduce the cost as much as possible without influencing the other factors.

For the better profit enterprises, it's better to adopt leadership strategic, pursuit constantly innovation, take themselves as the center, and gain stability in the market, in this way to make sure that there is no intense competition in the entire industry in terms of price, market share, technology, sales and other areas, which can create conditions for maintenance of leadership position [4]-[5].

5. Conclusions

(1) From the evaluation tests of 12 high-tech enterprises, it's proved that the comprehensive enterprise evaluation model which is constructed by Analytic Hierarchy Process (AHP) and multi-objective decision-making efficiency coefficient method having higher precision and better accuracy evaluation for high-tech enterprises.

(2)The method combined evaluate system with the intelligent decision support system can give feasible decision-making suggestions based on various evaluation results and give good guidance to enterprises.

(3) This system is an open system which can adapt to the changing through the consistent increase of the decision-making knowledge database.

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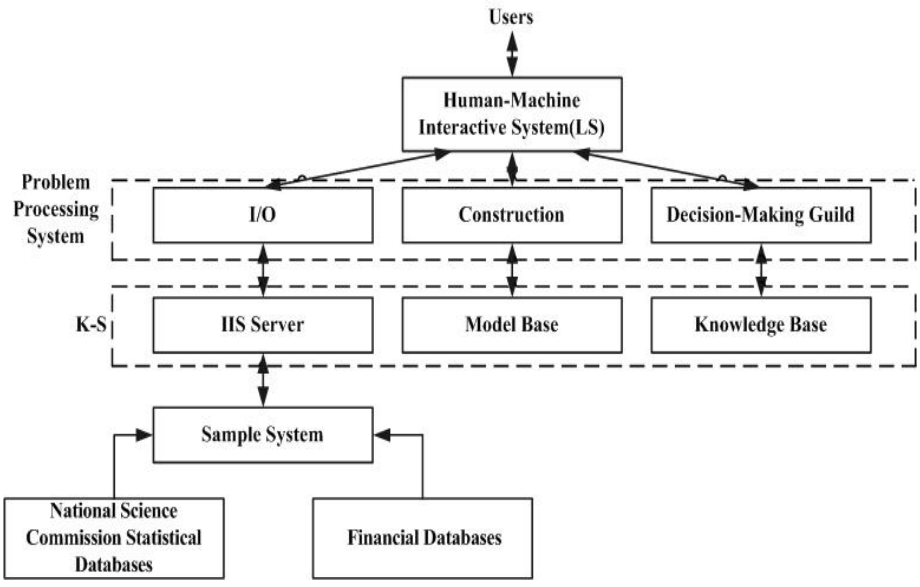

Figure 1. Sketch of System Framework

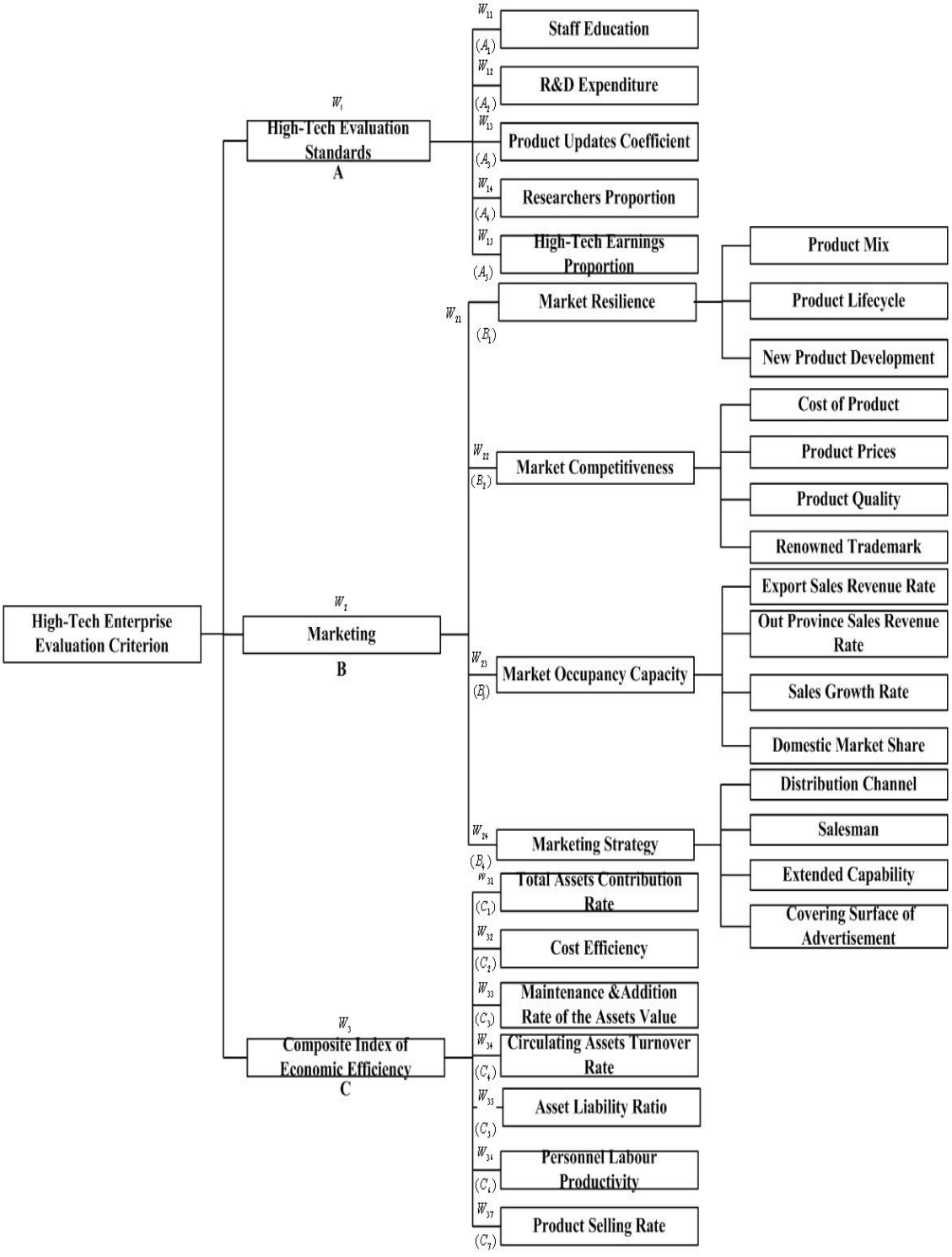

Figure 2. Hierarchical Chart of Evaluation Criterion

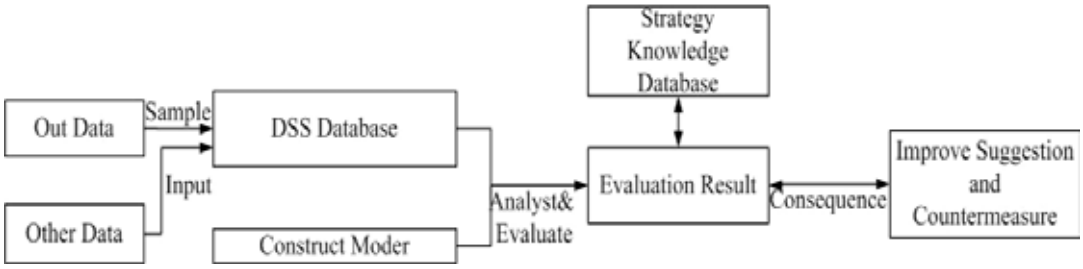

Figure 3. Hierarchical Chart of System Workflow