



Journal of Applied Sciences

ISSN 1812-5654

science
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Construction and Application of the Construction Enterprises Sustainable Performance Evaluation System

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Abstract: In order to evaluate sustainable development of construction enterprises evaluation model must be established. This study has analyzed the concept of corporate sustainability, established the sustainable evaluation framework, so as to establish evaluation index system. The level of development of all levels are calculated by the fuzzy evaluation method, the sustainability performance of enterprise can be calculated by the weighted sum of the level of sustainability at all levels. Finally, a large state-owned construction enterprise in Henan Province as an example of empirical analysis and the research concluded the sustainable performance of the enterprise by 0.525 in 2006 increase to 0.814 in 2012, according to the sustainable performance standard value of construction enterprises in Henan province, to measure that the enterprises has been achieved a “sustainable” level. Research shows that the index system has rich connotation, evaluation method is feasible which has certain guiding significance.

Key words: Construction enterprises, sustainable performance, evaluation system

INTRODUCTION

Sustainable development means the development of the society should not only the increasing demand of the people in modern time, but also not damage the benefit of future several generations (WCED, 1987). More specifically, the concept of corporate sustainability can be interpreted as: the development tragedy is that established on the basis of the triple bottom line of social, economic and environmental, can meet the current needs of the company and its shareholders while protecting, maintaining and upgrading to meet future needs in human, natural and social resources, whose purpose is to achieve the three highly uniform of corporate social responsibility, corporate economic goals, environmental protection and rational use of resources, so to maintain the coordination sustainable development of corporate and whole social.

Corporate sustainability performance assessment is a specific application of social sustainable development research in the microscopic field. At present, the country's research for sustainable development mainly starts from the macro perspective of the whole society, but the research from the microscopic perspective of the enterprise is still not systematic and perfect. Research on the sustainability performance of construction corporations has been done in this study which can improve the comprehensive competitiveness of corporations, guide corporations to achieve better social sustainable development strategy and has important

theoretical and practical significance for the sustainable development of construction industry and the whole society.

STUDY ON SUSTAINABILITY PERFORMANCE EVALUATION OF CONSTRUCTION CORPORATIONS

Establishing the frame of sustainability performance evaluation: Sustainability performance is an enterprise's performance and efficiency in achieving sustainability, it emphasizing the practical effect in business operations and resource utilization. Sustainability performance evaluation of corporations is an interdisciplinary research, it involves sociology, economics, environmental studies, business management and evaluation theory and many other subjects, therefore the system views should be used to integrate them.

Sustainability performance evaluation of construction corporations is to review the coordinating development between companies and social on the position of the whole society and to observe and study enterprises' contribution to sustainable development. Therefore, not only is the frame of sustainability performance evaluation able to monitor the daily operation of corporations, but also be able to be a corporate strategic management system. This requires frame of sustainability performance evaluation can include sufficient key performance indicators, as well as the balance among all the evaluation

aspects. According to the principles of the Balanced Scorecard (Maise, 1992; Bonanza Consulting, 2003). the following the frame of sustainability performance evaluation has been established.

From the framework shown in Fig. 1, we can see that sustainability performance evaluation of construction corporations is divided into five levels: finance affairs, project contracting, engineering projects, internal business processes, learning and growth and the indicator system of each level was designed from 3 different aspects, social, economic and environmental.

Establishment of evaluation index system: The setting up procedures of index system of building corporate sustainability performance evaluation is divided into two steps: Primaries and perfect. First, in accordance with the framework shown in Fig. 1, analyses enterprise sustainability performance from the three elements: social, economic and environmental at all levels, to establish sustainability performance evaluation index system initially. On this basis, use delphi method to screen the index and to improve indicators further. As is shown in Table 1, corporate sustainability performance evaluation system has a total of 33 indicators, of which 22 quantitative indicators, 11 qualitative indicators. Calculation methods of quantitative indicators can be seen reference (Ma, 2006) and qualitative indicators can be identified by the expert scoring.

SELECTING THE EVALUATION METHODS

Calculation method of every sustainability aspects: In this study, the fuzzy identification model (Ping and Yan, 2007)

has been used to calculate the level of development at all levels. The idea is: Divided the level of the various aspects of sustainability into four levels: Strong sustainability, sustainable, weak sustainable and unsustainable and through calculating each sample's degree of membership to each level to solve the level of sustainable level and the results is expressed in dimensionless values. Calculating steps are as follows:

Step 1: Determining the non-dimensional matrix of index $m \times n$ actual value index matrix $X = (X_{ij})_{m \times n}$ ($i = 1, 2, \dots, m; j = 1, 2, \dots, n$) for m samples (i.e., different stages of construction enterprise evaluation) and n assessing indicators were established, at the same time, create a sustainability the order of four levels $n \times 4$ of standard indicators matrix $Y = (y_{ih})_{n \times 4}$ ($h = 1, 2, 3, 4$). Apply indicators dimensionless method to calculate the actual value of the dimensionless index matrix $R = (r_{ij})_{m \times n}$ and the standard value of membership matrix $S = (S_{ih})_{n \times 4}$

Step 2: Calculate the weights of n evaluation index:

$$w = (w_1, w_2, \dots, w_n), \sum_{j=1}^n w_j = 1$$

Step 3: Calculate membership degree vector of sample i to level h . Use euclidean distance-weighted to indicate the difference between the sample i and the level h :

$$d_{ih} = \left\{ \sum_{j=1}^n [w_j (r_{ij} - s_{jh})]^2 \right\}^{\frac{1}{2}} \tag{1}$$

To solve the optimal membership degree u_{ih} of sample i to level h , establish the objective function:

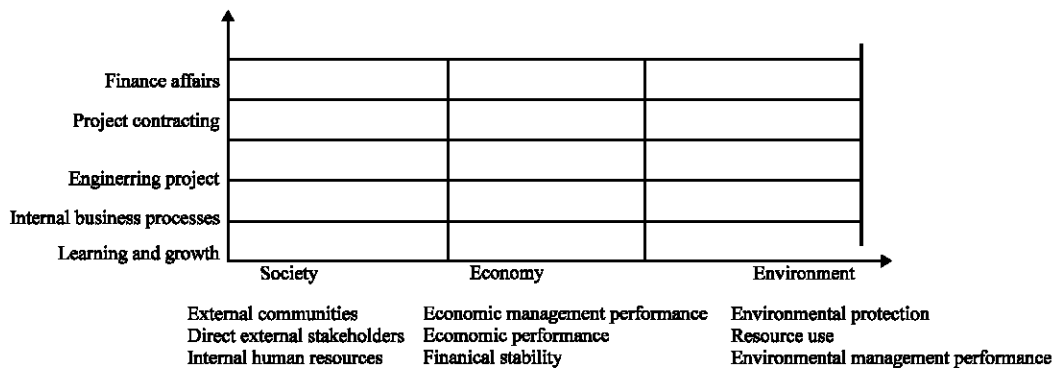


Fig. 1: Sustainability performance evaluation frame for construction corporations

Table 1: Sustainability performance evaluation index system of construction corporations

Object	Layers	Evaluation index
Sustainability performance of building corporate	Finance affairs	Return on total assets Return on equity Total assets turnover Current assets turnover Rate of capital accumulation
	Project contracting	(*) The reasonableness of the share of regional value (*) Value of each share of contract types rationality Successful rate Bidding efficiency Marketing efficiency
	Engineering Project	Important project quality accident rate Duration time completion rate (*) Project cost control level Owner satisfaction (*) the ability to manage subcontractors Energy efficiency of the building process Building materials attrition rate (*) The level of environmental pollution control (*) Completeness of health and safety management system On-site safety compliance rate of civilization Loss of security incidents
	Internal business processes	(*) Market procurement capacity (*) Degree of information management systems Full rate of technical equipment (*) New equipment, new technology and new technology promotion R and D expenditure accounted for operating income percentage Safety education coverage
	Learn and growth	labor productivity Staffing levels (*) The level of professional training of workers Employee satisfaction (*) Employee participation in decision-making of the enterprise Awards annually

*Marked as qualitative indicators and the rest is quantitative ones

$$\min \left\{ F(u_{ih}) = \sum_{h=a_i}^{b_i} (u_{ih} d_{ih})^2 \right\} \quad (2)$$

$$\text{s.t. } \sum_{h=a_i}^{b_i} u_{ih} = 1$$

Constructor Lagrange function and Lagrangian multipliers and the final result can be obtained:

$$u_{ih} = \left(d_{ih}^2 \cdot \sum_{k=a_i}^{b_i} d_{ik}^{-2} \right)^{-1} \quad d_{ik} \neq 0, a_i \leq h \leq b_i \quad (3)$$

In this equation: a_i and b_i is the upper limit and the lower limit level of sample i that is to say, the minimum and maximum values are obtained by comparing dimensionless values $r_{1i}, r_{12}, \dots, r_{ni}$ of n indexes of sample i with each row vector of the matrix S one by one

Step 4: Calculate development level of the sample i . Structure sustainability level matrix $S^* = (S^*_1, S^*_2, S^*_3, S^*_4)^T$ of the sample:

$$H_i = u_i \cdot S^* \quad (4)$$

Step 5: Similarly, we can calculate grade characteristic value vector of other aspects of sustainable level which are dimensionless values as well:

$$H = (H_1, H_2, \dots, H_m)^T \quad (5)$$

Step 6: Analyses the results

Calculation method for corporate sustainability performance: Corporate sustainability performance level can be obtained by weighting sum calculation results of various levels of sustainability, in which the weight of all levels can be determined by AHP (Lianfen and Shubo, 1990).

CASE ANALYSES

Applying the evaluating method provided by this article, sustainability performance study has been conducted on a large state-owned construction enterprise in Henan Province. In this study, the data for quantitative indicators stems from statistical information within the enterprise while the one for qualitative indicators and each index of the standard value at all levels is determined by the internal and external experts' study and scoring.

Table 2: Results of sustainability performance evaluation for a state-owned construction corporation in Henan province

Years	Finance (0.163)	Contracting (0.247)	Project (0.332)	Internal business processes (0.102)	Learn and grow (0.156)	Sustainability performance (1)
2006	0.737	0.330	0.646	0.307	0.495	0.525
2007	0.793	0.368	0.713	0.370	0.539	0.579
2008	0.852	0.411	0.783	0.432	0.585	0.636
2009	0.914	0.459	0.856	0.495	0.633	0.696
2010	0.941	0.512	0.875	0.557	0.683	0.734
2011	0.958	0.571	0.896	0.620	0.735	0.773
2012	0.972	0.639	0.918	0.683	0.789	0.814

Brackets for the weights of all levels

Table 3: Standard value of sustainability performance for construction corporations in Henan province

Sustainability level	Strong sustainable	Sustainable	Weak sustainability	Unsustainable
Sustainability performance	1	0.690	0.365	0

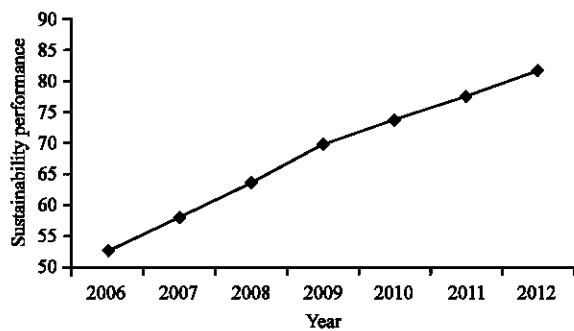


Fig. 2: Results of sustainability performance evaluation for a construction corporation in Henan province

Considering that the comparability and validity of the data, the evaluated time is determined from 2006-2012.

According to fuzzy recognition evaluation method, we can get this enterprise's sustainability performance development levels at the five layers. Meanwhile, we can calculate the value of sustainability performance criteria of the construction enterprises in Henan Province, so to measure the level of sustainability performance of the enterprise. As shown in Table 2 and 3, the horizontal axis represents the year while the vertical axis represents corporate sustainability score, then a corporate sustainability assessment results is shown in Fig. 2.

As it can be seen from the results, developmental level on two levels of the "contracting" and "internal business processes" is still relatively low in this enterprise. and these two levels should be the focal point of this enterprise in the future. Overall, the level of corporate sustainability performance of this enterprise keeps rising year after year, has reached "strong sustainable" from "sustainable" level. It indicate that the enterprise has actively implemented the sustainable development strategy in the production process and made corresponding contributions to the sustainable development of the whole society.

CONCLUSION

This study analyzes the concept of corporate sustainability, constructs framework of building corporate sustainability performance evaluation, establishes the evaluation index system, chooses evaluation methods and take a large state-owned construction enterprises in Henan as a case to do the empirical analysis. The evaluation results show that the concept of corporate sustainability is accurate, the evaluation framework is scientific and rational, the content of index system is rich and the evaluation method is feasible, all of which make it has a certain significance.

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