A COLLABORATIVE OPTIMIZATION MODEL FOR STRATEGIC PERFORMANCE

Zhang Hao, Cui Li, Zhou Yong-sheng and He Ming-ke
School of Business, Beijing Technology and Business University, Beijing, China
zhhaozhhao@126.com

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Abstract: The logical framework formed by enterprise strategic performance which designed from the dimensions of structure, capability and the culture is what we used to refine the key points of strategic performance. To construct a collaborative optimization model for strategic performance, it should be based on the overall optimization framework of collaborative optimization technology with the chaotic optimization method. The objective of system-level optimization is strategic performance optimization. The optimization goal of the subsystem-level is to make the difference between the designed subsystems and the subsystems provided by system-level optimization as little as possible. The numerical simulations show that the model is scientific and feasible.

1 INTRODUCTION

The operation of the enterprise consumes a variety of resources. Both the external resources and the internal resources are factors that affect the enterprise strategic objectives. Allocation of resources is the key content of strategic development, strategy implementation and strategic control. It is in the process of being continuous optimized. The optimization of strategic performance can be achieved by allocating the limited resources so as to maximize the performance, and create cost-effective for companies, so that the limited resources can get into the most lucrative returns. How to effectively optimize the performance of the strategy is an important task both in theory and practice community. Based on the concept of collaborative optimization, this paper forms the strategic synergy mechanism operation framework with the sub-systems coupling by structure, capability and culture, and composes collaborative optimization model for strategic performance combined with chaos optimization method and makes numerical simulation.

2 THE LOGICAL FRAMEWORK OF THE FORMATION OF ENTERPRISE STRATEGIC PERFORMANCE

Strategy performance optimization is to comprehensively and dynamically adjust the input-output relations between the financial elements and non-financial elements which will influence strategy performance, so as to achieve the enterprise overall strategy performance optimization. Strategic system consists of the structure, capacity and cultural composition, as shown in Figure 1. The three dimensions are coupling with one another, interrelated and mutually supporting. The strategic system adjusts the relationship between the three dimensions according to changes in the internal and the external environment of the enterprise. It will adjust the configuration of resources and the extent of influence in order to make sure the strategic performance optimization. Cooperating the sectors of enterprises and the resource allocation, making the strategy performance always maintain the optimal status, adjusting the disharmony factors between enterprise and its business environment, and correcting deviations in time will help enterprise adapt to the external environment better. After all the strategic business units are aware of the stimulation

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from the external environment, they will achieve information sharing by initially screening and analyzing the information then communicating with each other. Thus, the strategic business unit formed a coupling relationship. However, the coupling manner and extent are not determined by the strategic business units. They pass the information to the strategy system, and then the strategy system calculates and balances the internal and external environment status and the development trend comprehensively. On one hand it will pass the amended information to the strategic business units, on the other hand it will export the strategic collaborative performance. The strategic business unit adjusts the coupling relationship between each other according on the instruction passed by the strategic layer, so that to achieve a dynamic optimization strategy and to ensure that the companies can adjust their strategies timely.

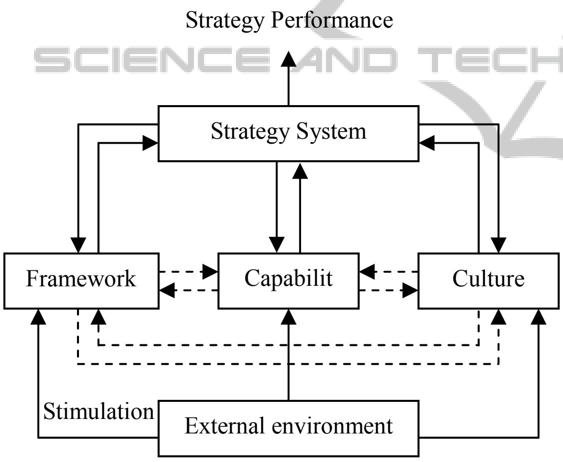

Figure 1: Logical Framework Which Strategy Performance Formed.

3 PRINCIPLES OF COLLABORATIVE OPTIMIZATION FOR STRATEGIC PERFORMANCE

This paper uses the idea of collaborative optimization for reference to design the principles of collaborative optimization for strategic performance. Collaborative optimization is method proposed by Braun which decomposing, coordinating and integrated optimizing according to one discipline to multidisciplinary designed optimization. Each discipline's calculations have a very good degree of autonomy, without taking into the account of the impact of other disciplines. The basic framework of collaborative optimization consists of optimization of system-level and subsystem level. In sub-system optimization, design variables are only related to the design parameters of the discipline involved with and coupling variables of other related disciplines. If it meets the requirement of the internal constraints of the subsystems, the optimization objective is to make the difference between the optimization solution of the subsystem and system level as minimum as possible. The task of system-level optimization is to make the best overall objective of the system, and coordinate activities of the various subsystems so that the variance between each sub-system's optimization results will gradually decrease. Taking strategic system as the system-level of optimization, structure, capability, culture as a subsystem (which can also be divided from other aspects), the coupling relationship between subsystems will be determined by the system level optimization.

Definition I. During the process of designing and operating the enterprise strategy system, collaborative optimization for enterprise strategic performance must analyze the extent of the interaction between subsystems, and adjust the models and methods of enterprise system optimization by taking advantage of these interactions.

Definition II.

$$\Delta_{System} = (\sum_{i} \Delta_{Subsystem}) + \Delta_{Co} \qquad (1)$$

In equation (1), Δ_{System} means the overall system performance, $\sum_{i} \Delta_{Subsystem}$ is the sum performance of subsystem, and Δ_{Co} means the increment calculated the interaction between the various subsystems after collaborative optimization.

Definition III. Subsystem: The basic module in enterprise system which are independent in functions but keeping mutual exchange of information and material as well. Such as: sales department and production department, finance department and sales department.

Definition IV. Design variables: A group of independent variables used to describe the characteristics of the strategic system, and can be controlled in the design process.

Definition V. State variables: A set of parameters used to describe the function or characteristics of the system or subsystems.

Definition VI. Constraints: The constraints needed to be met during the operation of system or subsystems.

Definition VII. System Collaborative Optimization: In collaborative optimization for strategic performance, the subsystems coordinate for their common strategic goal - the best of the overall enterprise systems. The relationship of each subsystem is more cooperative. System layer is responsible for planning, coordination and leading the overall direction of optimization; subsystem is responsible for the compatibility optimization, and study the feasibility of the direction of optimization.

The mathematical description of collaborative optimization for strategic performance as:

System layer: $\min f(x)$

$$s.t. \quad C_i(x) = 0$$

Sub-system layer： $\min C_i(x^*)$

$$s.t. \quad g_i(x)$$

$$C_i(x) = (x - x^{**})^T (x - x^{**})$$

$$C_i(x^*) = (x^* - x)^T (x^* - x) \quad i = 1,2,3,\cdots,n$$

In the equation above: x is the system level design variables, $f(x)$ is the objective function, $C_i(x)$ is the compatibility constraint of subsystem i, x^* is the design variables of sub-system layer, x^{**} is the design variables' optimization results of subsystem, $C_i(x^*)$ is the objective function for the subsystem i, n is the number of the variables.

4 THE COLLABORATIVE OPTIMIZATION MODEL FOR STRATEGIC PERFORMANCE

The structure of Collaborative optimization model can be designed according to the logical framework of strategic performance. It can be divided into two levels: system level and subsystem level. System layer is responsible for the overall strategic systems optimization; the sub-system layer is responsible for the optimization of the subsystem itself. The system level and subsystem layer have got a close coupling relationship. The subsystem-level's optimization goal is to make the difference between the designed subsystems and the subsystems provided by system-level optimization as little as possible.

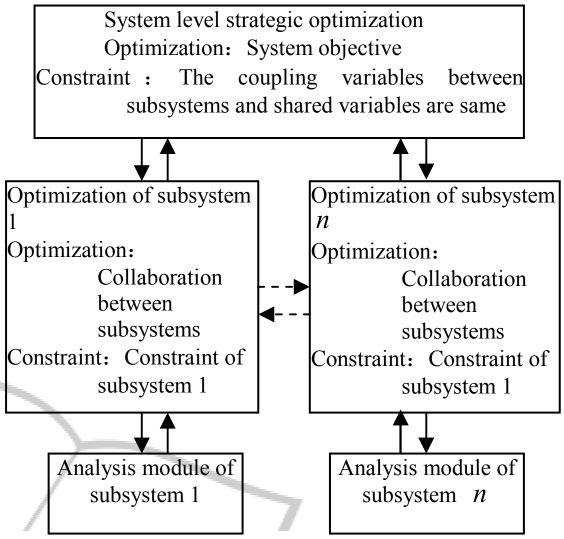

Figure 2: Framework of Collaborative Optimization for Strategic Performance.

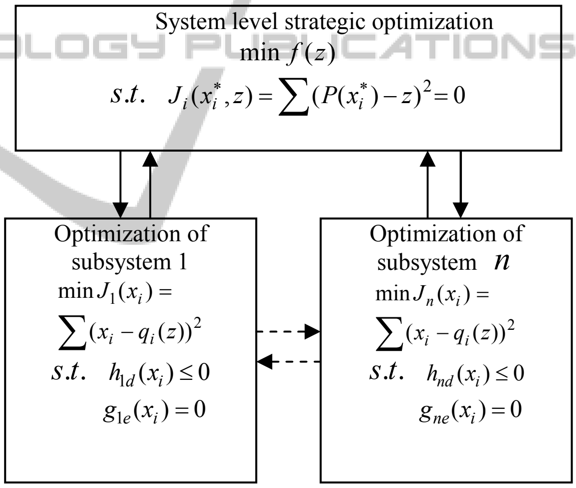

Figure 3: Function for Collaborative Optimization for Strategic Performance's Framework.

The strategic elements of structure dimension contain capital structure, product structure, organizational structure and personnel structure. The strategic elements of capacity dimension include marketing capability, management capability, innovation and decision-making capability. The strategic elements of culture dimension consist of values, cohesion, entrepreneurship, enterprise learning. Standardized the value of the performance elements of the strategy, making x_i represents the performance value of the i strategic element, $f(x)$ for the system level performance value, f_1, f_2, f_3 for performance value corresponding to the three subsystems respectively. As enterprise systems with the feature of complexity, chaos and collaboration, so combined the collaborative optimization with chaos optimization, collaborative optimization model for strategic performance is shown below. In this model x^* is the optimal solution calculated by the system, x^{**} is the optimal solution returned by the subsystem, α is for the weight. Strategic performance is the bigger the better, therefore, in the design of system level, we take $f(x)$ as the reciprocal of the value of strategic performance.

(1) System layer：

$$\min f(x) = 1/\sum_{i=1}^{12}\alpha_i x_i \quad (2)$$

$$s.t. \quad 0 \le x_i \le 1 \quad (i = 1,2,\cdots,12)$$

$$f_1 = \sum_{i=1}^{4}(x_i - x_i^{**})^2 + (x_6 - x_6^{**})^2 + (x_8 - x_8^{**})^2 + (x_{11} - x_{11}^{**})^2 + (x_{12} - x_{12}^{**})^2 = 0$$

$$f_2 = \sum_{i=5}^{8}(x_i - x_i^{**})^2 + (x_1 - x_1^{**})^2 + (x_2 - x_2^{**})^2 + (x_{10} - x_{10}^{**})^2 + (x_{12} - x_{12}^{**})^2 = 0$$

$$f_3 = \sum_{i=9}^{12}(x_i - x_i^{**})^2 + (x_3 - x_3^{**})^2 + (x_6 - x_6^{**})^2 + (x_7 - x_7^{**})^2 = 0$$

(2) Subsystem layer：

① Subsystem 1：

$$\min f_1 = \sum_{i=1}^{4}(x_i - x_i^*)^2 + (x_6 - x_6^*)^2 + (x_8 - x_8^*)^2 + (x_{11} - x_{11}^*)^2 + (x_{12} - x_{12}^*)^2 \quad (3)$$

$$s.t. \quad 0.5 \le x_1 \le 0.9$$
$$x_1 \ge 0.5x_6 + 0.5x_8$$
$$x_3 \le 0.95$$
$$x_4 \ge 0.4x_{11} + 0.6x_{12}$$

②Subsystem 2：

$$\min f_2 = \sum_{i=5}^{8}(x_i - x_i^*)^2 + (x_1 - x_1^*)^2 + (x_2 - x_2^*)^2 + (x_{10} - x_{10}^*)^2 + (x_{12} - x_{12}^*)^2 \quad (4)$$

$$s.t. \quad 0.6 < x_5 < 0.95$$
$$0.5x_2 + 0.5x_{10} \le x_5$$
$$x_7 \ge 0.4x_4 + 0.6x_{12}$$
$$x_8 \ge 0.5x_{10} + 0.5x_6$$

③Subsystem 3：

$$\min f_3 = \sum_{i=9}^{12}(x_i - x_i^*)^2 + (x_3 - x_3^*)^2 + (x_6 - x_6^*)^2 + (x_7 - x_7^*)^2 \quad (5)$$

$$s.t. \quad x_9 \le 0.9$$
$$x_{10} \ge 0.4$$
$$0.3x_9 + 0.7x_{11} \le x_{10}$$
$$x_{11} \ge 0.5$$
$$x_{12} \le \sqrt{x_7 x_{10}}$$

If x_i generated by the chaotic sequence cannot satisfied the constraints, then transformed x_i ,take $x_i(k) = c_i + d_i x_{i,n+1}$, c_i is the lower limit for the constraint, d_i is the absolute value of the difference between the upper and lower limit constraints.

5 MODEL SIMULATIONS

Standardize the performance evaluation of strategic elements of the enterprise, each evaluation value is somewhere in between $[0,1]$. The weight of each index, initial value, final value, function values are shown in Table 1.

Table 1: Simulation Data.

x_i	α_i	x_i initial value	x_i final value	min $f(x)$	min $f^{**}(x$
x_1	0.092	0.946	0.527	3.106	1.145
x_2	0.105	0.173	0.351		
x_3	0.067	0.146	0.864		
x_4	0.057	0.909	0.569		
x_5	0.112	0.195	0.746		
x_6	0.085	0.591	0.023		
x_7	0.073	0.139	0.459		
x_8	0.096	0.109	0.814		
x_9	0.064	0.188	0.870		
x_{10}	0.095	0.161	1.000		
x_{11}	0.078	0.241	1.000		
x_{12}	0.076	0.210	0.026		

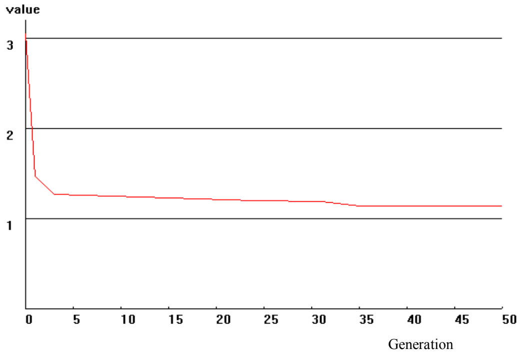

Figure 4: Alternation curve with $n = 50$.

The value of each index of current enterprise's performance is the initial value. Through optimized, each index can obtain its relative optimum value in the strategic systems. When the time f alternation is 50, the optimization curve is what's shown in Figure 4. When the initial function value is 3.106, the corresponding value of the strategic performance is 0.322. After iterations, the optimal function value is 1.145, the corresponding optimal value is 0.873. That's optimal value is the theoretical value, the state it corresponds to is ideal, which may have got some difference with the reality. For example, the optimal value which corresponds to the management ability x_6 and the corporate learning x_{12} is too small. The deviation with the actual situation is the result of the constraint set. The relative optimal value is theoretical. In practice, there may be a variety of uncontrollable factors. In theory, if we can express each influential factor by function scientifically and reasonably, and set the corresponding constraints, then the method can offer useful ideas for enterprise strategy collaborative optimization.

6 CONCLUSIONS

This paper designs principle and structure about strategic performance collaborative optimization the bases on the concept of collaborative optimization, composes operation collaborative optimization model combined with chaos optimization method and makes numerical simulation. Taking strategic system as the optimization system-level, analyzing strategic elements from dimensions of structure, capability and cultural, the coupling relationship between subsystems is determined by the system-level optimization. Strategy system calculates and balances the internal and external environment status and the development trend comprehensively. On one hand it will pass the amended information to the strategic business units, on the other hand it will export the strategic performance. The strategic business unit adjusts the coupling relationship between each other according on the instruction passed by the strategic layer, so that to achieve a dynamic optimization strategy, which reflects the consistency and collaboration of the internal and external environment. The model is feasible in theory proved by numerical simulations, in practice, it still needs to set more comprehensive and specific data conditions.

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