

Research on Model of Harmony Sustainable Development between ECS and SRS:

from Perspective of Resource Entropy

RECHERCHE SUR LE MODÈLE DU DÉVELOPPEMENT DURABLE HARMONIEUX ENTRE ECS ET DE SRS:

DE LA PERSPECTIVE DE L'ENTREPIE DES RESSOURCES

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Abstract: Combining the theory of dissipative structure systems, resource entropy and stakeholder, the article gave the definition of Stakeholder Resource System (SRS), analyzed sustainable development model of Enterprise Complex System (ESC) from the perspective of resource entropy, as well as sustainable development model of stakeholder resource system. Finally, based on the above analysis, the article studied Harmony Sustainable Development model of ECS and SRS.

Key words: Stakeholder Resource System; Enterprise Complex System; Resource Entropy; Harmony Sustainable Development

Résumé: En combinant la théorie du système de structure dissipative, l'entropie des ressources et les intervenants, l'article a donné une définition du système des ressources des intervenants(SRS), analysé à la fois des modèles de développement durable du système complexe de l'entreprise(CES) du point de vue de l'entropie des ressources et des modèles de développement durable du système des ressources des parties prenantes. Enfin, à part l'analyse ci-dessus, l'article a étudié également le modèle du développement durable harmonieux d'ECS et de SRS.

Mots-Clés: système des ressources des intervenants, système complexe de l'entreprise, entropie des ressources, développement durable harmonieux

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1. FORWARD

The chemical enterprises around Taihu Lake whose emissions did not meet standard were forced to close because of the outbreak of cyanobacteria events; ECS of Sanlu milk powder collapsed because of Melamine events. These enterprises have not been able to achieve sustainable development. The essence is that ECS is disloyal to stakeholder which provides exclusive resource. They discarded a large amount of scrap entropy to SRS, which is really beyond its ability of regeneration and purification, causing increased confusion of internal SRS, inducing mutation, leading to no sustainable development of SRS, consequently affecting the sustainable development of ECS. The study on sustainable development of SRS and ECS, harmony sustainable development of SRS and ECS is imminent.

2. DEFINITION OF SRS AND ECS

Enterprise system is a complex system (CHEN, 2000). ECS is an integrated system consisted of human resources, financial resources, material resources, information resources and many other elements under a certain goal. It obtains all the necessary resources elements from resources environment which is used for production and operation activities, according to available market information, a variety of resource allocation methods such as physical, chemical or biological methods. It combines various resource elements together organically according to intended purpose, producing a product or service and delivery to the needs of the market, to meet the resource demand of user and human, and get profit (Figure 1).

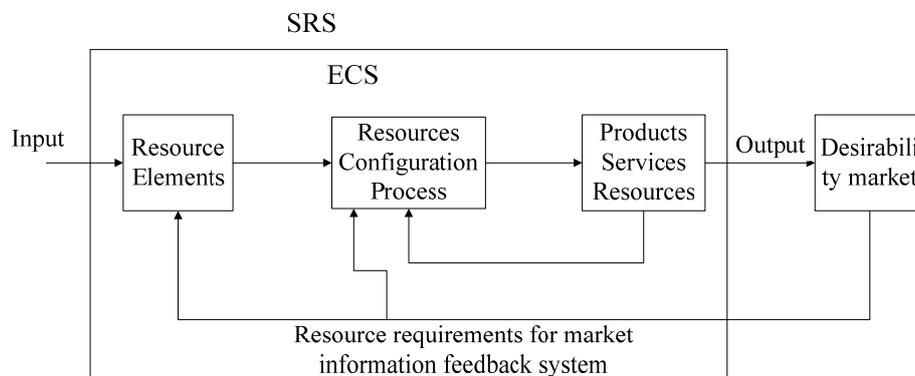


Figure 1: Resource flow diagram of Enterprise Complex Systems

With the development of ECS management theory, Stakeholders problem has become an integral part of existing governance framework of ECS (OU, 2007). Stakeholders are those individuals and groups who take a certain amount of specific investments and assume a certain risk, whose activity can influence, even change the achievement of business goals, and can be influenced by processes of achievement of business goals (JIA & CHEN, 2003). Stakeholders can be divided into ECS internal stakeholders and external stakeholders. According to its properties, external stakeholders can also be subdivided into external social attributes stakeholders and external natural attributes stakeholders (Figure 2).

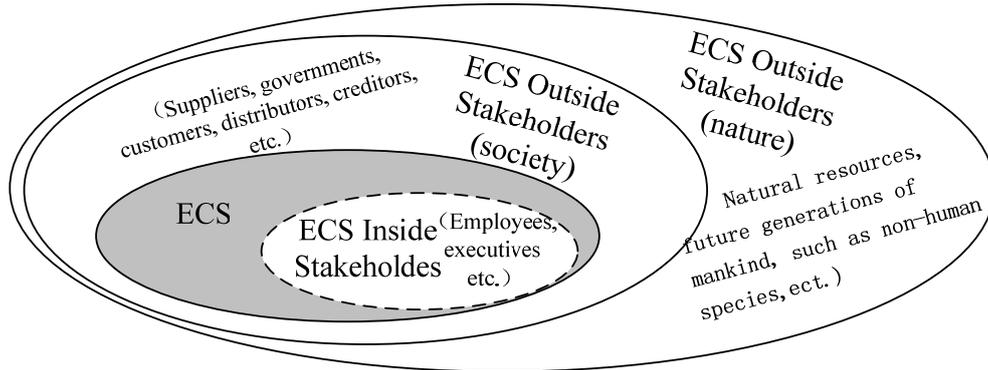


Figure 2. Classification map of stakeholders based on internal and external of ECS

Resources are the material basis for existence and development of human beings and human organizations. Stakeholders provide proprietary resources for ECS, one of human organizations. SRS is the system to provide proprietary resources for ECS, with system characteristics, including internal stakeholders resources subsystem of ECS, external social attributes stakeholders resources subsystem of ECS, external natural attributes stakeholders resources subsystem of ECS (Figure 3). SRS is coupling together with ECS through entropy flow, both of which must be harmoniously and sustainably developed, then human beings and human society can be sustainably developed.

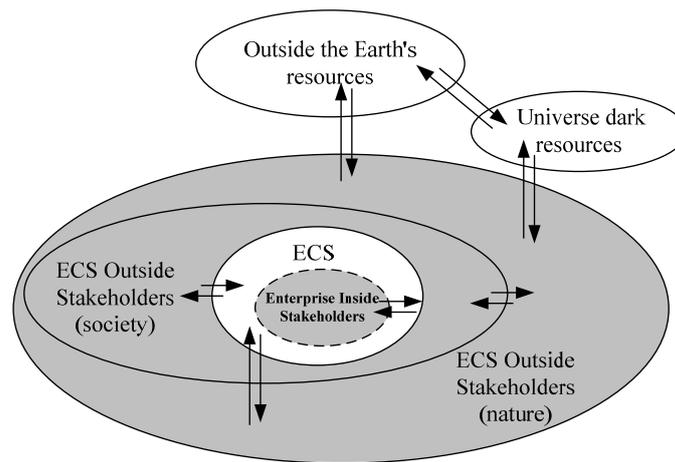


Figure 3. Stakeholders' resources system chart and entropy flow

3. SYSTEM THEORY OF DISSIPATIVE STRUCTURE OF SRS AND ECS

With the rapid development of science and technology, demand and consumption habits of human beings are changing a lot, resource structure of SRS is undergoing great changes. In order to adapt to changes of SRS, ECS is experiencing unprecedented changes in different evolution. How to grasp sustainable development of ECS in essence, and then guide the change activities of ECS, adapt and improve SRS, and ultimately, get harmony sustainable development together with SRS, will be a huge problem presented in front of human beings. Dissipative structure theory, taking studying the evolution of complex systems as its responsibility, provides us with a new perspective and new ideas to solve

problems (LIU, 2001).

The formation conditions of dissipative structure system: 1) open system contains a large number of elements, and continuously exchange material, energy and information with outside of the world; 2) the outside world must drive open system to exceed balanced linear region, reach non-linear zone which is far away from the equilibrium state; 3) System contains an appropriate nonlinear feedback, such as positive and negative feedback mechanisms and so on; 4) Fluctuation has played a role of triggering and intensifying to the formation of dissipative structures, it's flip-flop of the formation of dissipative structure.

ECS is a dissipative structure system. Usually ECS contains a large number of primitives and multi-level component, that is, it contains a large number of elements, such as members, resource factors, managing factors and so on. And under the condition of a market economy, each ECS is an open system, continuously exchange entropy with SRS such as material, energy and information; Enterprise system behavior exists objectively, whose state set and environment set are non-empty sets. State parameters change according to changes in time, space and uneven development. It is a dynamic system, with a potential difference, causing competition and forming a variety of dynamic flow and strength, driven by external environment, regular fluctuations and random perturbation are superimposed, then appears new fluctuation, driving systems away from equilibrium; ECS also has small fluctuation factor, when information are exchanged between ECS and SRS, internal a certain parameter innovating through fluctuation when perceiving external variables achieves a certain critical point. ESC is possible to produce changes from high entropy to low entropy, from one ordered structure to another more advanced ordered structure; The effects made from nonlinear interaction between the various sub-systems of ECS are greater than the sum of all parts; the interaction between them can produce coherent effects and critical effect between the various sub-systems of ECS. These two effects are internal power to promote ECS to come to order, important mechanism and necessary conditions for formation of dissipative structures of ECS.

SRS is also a dissipative structural system. It is an open system. Changes of system entropy are not only affected by irreversible process of itself, that is, the effect which system entropy produced, but also affected by entropy flow. Entropy flow is caused by exchanges for material, energy, information and so on between SRS, ESC and external world; entropy of SRS is stochastic volatility and fluctuation which is affected by entropy increase of human being, comprised of human organization, and resources entropy outside the earth and dark resources entropy and some other outside entropy. They drive SRS away from equilibrium; When SRS exchange entropy flow with the outside world, a number of internal subsystems are in a border state, SRS is likely to occur huge change because of some small fluctuations, maybe from low entropy to high entropy, maybe from one low-level nonrandom structure to another high-level nonrandom structure; natural resources subsystem and social resources subsystem of SRS, internal resources subsystems of ECS, their coordinated non-linear effect makes the overall effect greater than the sum of the various subsystems. Competition between them makes the various subsystems produce coherent effects and critical effects. These two effects are internal power to promote SRS to come to a more advanced and orderly nonrandom structure.

4. DEFINITION OF RESOURCE ENTROPY

Physical and chemical changes process of a variety of resources is the process of entropy change, entropy can measure the changes of resources or energy, can discuss problems of Stakeholder resources system and so on from the perspective of entropy theory, from creation and development until now, entropy theory developed from a purely thermodynamic physics concept of describing the micro-world, to a unified concept of natural system and social system, economic system and ECS. At the same time, the introduction of entropy concept will enhance people's understanding to essence of relationship between enterprise development and development of economy, environment and resource. In fact, the

entire space entity is full of entropy flow, metabolism of any of a life. Its input-output or production and consumption are directly or indirectly related with entropy (CHEN et al, 2006). Entropy always runs through the natural environment and human social and economic activities. It also includes environmental pollution, economic system disorder, social complex issues and so on. Based on the above point of view, research on the relationship between development and utilization of resources and ecological environment with entropy concept, and the entropy increase of ECS was put forward. The model of symbiotic sustainable development of enterprise development and stakeholder resource system was built up on the basis of entropy. Through the research on this model, it has important significance for sustainable development model research and sustainable development decision-making.

The degree of system's disorder is measured with entropy. Such a state of disorder arises due to consumption of system, therefore consumption accompanied emergence of entropy. Proliferation capacity of resources is human's capacity of consumption to resources, thus linking the proliferation capacity of resource, capacity of consumption and entropy together. Entropy resources are defined. Resources entropy was interpreted that resources has potential capacity of entropy increase to economic system, and capacity of entropy increase was carried out with the ability of proliferation. The ability of entropy increase is: when resources are spread to ECS, the measurement for disorder state which was caused by stakeholder resources environment. The theory of resources entropy studied process of transformation from resources to waste, waste heat, and explored use condition of updated resources under the circumstances of no depletion and pollution, thereby revealed unified law as consumption and production, survival and demise of heat engine, biology, economy, ecology and other systems. It should be the basis of theoretical study of sustainable development.

5. RESEARCH ON HARMONY SUSTAINABLE DEVELOPMENT BETWEEN ECS AND SRS FROM PERSPECTIVE OF RESOURCE ENTROPY

According to the theory of dissipative structure, on the assumption that under the conditions of local equilibrium, in a small time interval dt , the entropy change of open system dS is made up of two parts: one part is entropy increase caused by irreversible process in the internal system, also called entropy production $d_i S$; another part is entropy change caused by exchange energy and material between system and outside world, called entropy flow ($d_o S$). The total entropy change (dS) of open system is the summation of entropy production and entropy flow, that is,

$$dS = d_i S + d_o S \quad (1)$$

Formula (1): S is state function entropy; d is a total change; $d_i S$ is entropy increase caused by irreversible process in the internal system, also called entropy production; $d_o S$ is entropy change caused by exchange energy and material between system and outside world, called entropy flow.

We can see from entropy principle: $\frac{d_i S}{dt} > 0$, then $\frac{d_o S}{dt}$ may be positive, negative and zero.

$\frac{dS}{dt} = \frac{d_i S}{dt} + \frac{d_o S}{dt}$ can measure system status, more negative entropy, more orderly, then the system is stable (PAN, 1997).

(1) $\frac{dS}{dt} = \frac{d_i S}{dt} + \frac{d_o S}{dt} < 0$, this shows an increase in an orderly manner, then ought to be $\left| \frac{d_o S}{dt} \right| < \left| \frac{d_i S}{dt} \right|$, that is, the input stream of negative entropy flow offsets the entropy production of internal system, and leave a surplus of negative entropy.

(2) $\frac{dS}{dt} = \frac{d_i S}{dt} + \frac{d_o S}{dt} > 0$, this shows lower degree of order. There are two situations:

(a) $\frac{d_i S}{dt} \geq 0, \frac{d_o S}{dt} \geq 0 \Rightarrow \frac{dS}{dt} > 0$;

(b) $\frac{d_i S}{dt} \geq 0, \frac{d_o S}{dt} < 0$, but $\left| \frac{d_i S}{dt} \right| > \left| \frac{d_o S}{dt} \right| \Rightarrow \frac{dS}{dt} > 0$, there is no input of negative entropy flow or the amount of input of negative entropy can not offset the amount of entropy production of the system.

(3) $\frac{d_i S}{dt} + \frac{d_o S}{dt} = \frac{dS}{dt} = 0$, this shows that degree of order will remain basically unchanged, that is $\left| \frac{d_o S}{dt} \right| = \left| \frac{d_i S}{dt} \right|$.

In 2006, MIAO Yan-qing and YAN Li-dong derived some related formulas (MIAO & YAN, 2006) in the article of research on economy of entropy increase minimization and sustainable use of resources, Based on the actual characteristics of ECS, further to understand the entire ECS, and analyze by using entropy change model.

The change of total entropy of ECS dS is made up of $d_o S$ and $d_i S$ two parts, the former entropy flow was caused by exchanging material, energy and feedback control; the latter entropy increase was caused by irreversible process of ECS itself, with this principle, gave the entropy change formula of ECS:

$$dS_1 = d_o S_{-12} + d_o S_{+12} + d_o S_{-11} + \sum_{k=1}^n d_i S_{1k} \quad (2)$$

In this formula: dS_1 stands for entropy flow with SRS, $d_o S_{-12}$ stands for negative entropy flow from compensation SRS of improving enterprise system and technological innovation, $d_o S_{+12}$ stands for entropy increase caused by excessive seeking and inappropriate production behavior of ECS to SRS, $d_o S_{-11}$ stands for sum of negative entropy flow of capacity of restoration and self-purification of SRS and negative entropy flow of external resource system, $\sum_{k=1}^n d_i S_{1k}$ stands for total entropy increase caused by energy dissipation of multiple subsystems in SRS.

$$dS_2 = d_o S_{-21} + d_o S_{+21} + d_o S_{-22} + \sum_{k=1}^n d_i S_{2k} \quad (3)$$

In this formula: dS_2 stands for entropy change of ECS itself, $d_o S_{-21}$ stands for negative entropy flow of supply energy of SRS to enterprise production and management, $d_o S_{+21}$ stands for entropy

increase caused by the disaster of SRS, $d_o S_{-22}$ stands for negative entropy flow caused by self-organization of ECS, $\sum_{k=1}^n d_i S_{2k}$ stands for entropy increase caused by process of changes and consumption in human and human organization.

In terms of a non-equilibrium state, when the entropy increase is minimum, the system comes to maximize. In order to maintain the sustainable development of ECS itself, then the absolute value of negative entropy flow caused by transformation process about material and energy between ECS and SRS should be bigger than sum of entropy increase caused by interference of ECS and entropy production caused by ECS itself, therefore ECS needs continually absorbing energy and material from the SRS to increase the value of negative entropy flow, that is to increase the value of $d_o S_{-21}$ continuously, at the same time, the entropy increase of ECS should be reduced, ECS needs to discharge its own entropy increase, and the effect of the part of entropy increase to SRS is $d_o S_{+12}$ in formula (3), so sustainable development model of ECS is (Figure 4):

$$|d_o S_{-21} + d_o S_{-22}| > d_o S_{+21} + \sum_{k=1}^n d_i S_{2k} \quad (4)$$

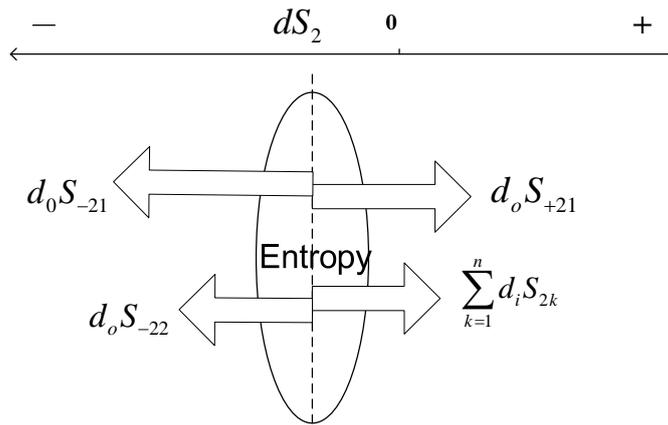


Figure 4. Force field chart of entropy change of ECS

When ECS asks for resource $d_o S_{-21}$ from SRS with increased frequency and amount, more entropy increase is discharged to SRS. SRS could not purify these entropy increase $d_o S_{+12}$. SRS comes to the state of confusion, that is $d_o S_{-11}$ reduced, the confusion of SRS will feedback to ECS, caused confusion of ECS, in order to eliminate confusion, ECS will ask for more negative entropy from SRS, so the cycle continues to produce a human society and environmental issues and ecological crisis, to avoid the problem of human society and the environment and the ecological crisis, SRS must be healthy for Sustainable development, we can get the sustainable development model of SRS according to (2) formula(Figure 5):

$$|d_o S_{-12} + d_o S_{-11}| > d_o S_{+12} + \sum_{k=1}^n d_i S_{1k} \quad (5)$$

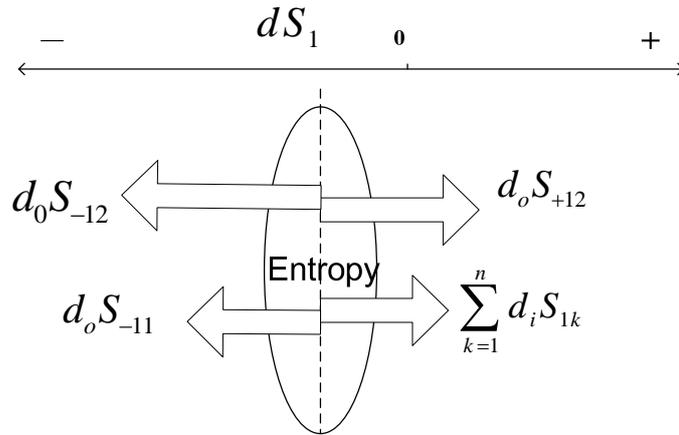


Figure 5. Force field chart of entropy change of SRS

According to the formula (4) and (5), in order to achieve the coordinated development of SRS and ECS, the total entropy of negative entropy flow of improvement and compensation of ECS to SRS, negative entropy flow of capacity of restoration and self-purification of SRS, negative entropy flow of external resource system must be greater than or equal to negative entropy flow of energy to supply to overall ECS of SRS and other negative entropy flow of consumption, according to the formula (4) and (5), achieve the coordinated development model of SRS and ECS:

$$\begin{aligned}
 |d_o S_{-21} + d_o S_{-22}| &> d_o S_{+21} + \sum_{k=1}^n d_i S_{2k} \\
 |d_o S_{-12} + d_o S_{-11}| &> d_o S_{+12} + \sum_{k=1}^n d_i S_{1k} \quad (6) \\
 |d_o S_{-12} + d_o S_{-11}| &\geq \sum_{k=1}^n d_i S_{1k} + \sum_{k=1}^n |d_o S_{-21}|_k + d_o S_{+21}
 \end{aligned}$$

6. CONCLUSION

Research on sustainable development of human beings and human organizations based on resource entropy is a new research perspective, which is able to reveal the essence mechanism of harmony sustainable development of SRS and ECS : model 4、5 gave the conditions for sustainable development of ECS and SRS. Model 6 gave the conditions for harmony sustainable development of SRS and ECS. ECS must take the initiative during the harmony sustainable development of ECS and SRS, through technical innovation and improvement of production and consumption habits, in the course of the use of resources to achieve the minimum of entropy increase and to maximize effectiveness of negative entropy resource. The target of enterprise entropy increase is zero emissions, at least to achieve per unit time entropy increase of waste less than or equal to negative entropy resource of renewable and self-purification of SRS. In the process of production and management, in order to attribute to renewal and self-purification of SRS, ECS should take it as one of the objectives of corporate governance business. Only if SRS achieves sustainable development, human beings and human organizations can achieve sustainable living; Only if ECS achieves sustainable development, the quality of human life can be increased.

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