Evolutionary Mechanism of Self-organization of University Core Competence Construction Engineering System

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Abstract

There is an important transition from analytical paradigm to systematic engineering paradigm in the method of research on university core competence. As a new trend of system engineering theory, self-organization theory focuses on the study of the mechanism, condition and law of system evolution from disorderly to orderly and low to high stages. The purpose of this paper is to answer what constituent elements of university core competence construction engineering system are, what its self-organization characteristic is and how to evolve its self-organization system. Firstly, this paper has discussed its constituent elements and structural model by systematic engineering method; Secondly, this paper has revealed its self-organization characteristics by utilizing organization theory; Finally, this paper has established the dynamic engineering model of its organization evolution by using organizing theory. The innovative point of this paper is that based on the definition of resources gain and conformity competence, personnel training competence, educational reform and innovation competence, scientific research competence, social service competence and management innovation competence the university core competence construction engineering 6 strength engineering dimension structural model and its system dynamic engineering model have been constructed in order to discuss the evolving mechanism of university core competence construction engineering self-organization system.

Key words: University Core Competence; Construction Engineering System; Self-organization Theory; Self-organization Evolutionary Mechanism; Potential Function

1. Introduction

Under the general trend of education informationization, modernization and globalization the core competence are the foundation of university's survival and development. It is also the basis of the university growth. University development process in fact is the process of the university core competencies' accumulation, agglomeration and formation. Since American management scientist C.K.Prahlad and Gray Hamel (1990) proposed for the first time the core competencies theory\textsuperscript{[1]}, the theory has become a continuing hot topic of concern of business management, education administration and other numerous research areas. In recent years university core competence study has been from the traditional paradigm of analysis to the systematic engineering paradigm and has made some valuable theoretical results. For example Feng Ming and Fang Yaomei (2009) from the self-organization angle have conducted the research to the university core competitiveness's evolution mechanism.\textsuperscript{[2]} Zhong Weidong (2007) has

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established the university core competitiveness evaluation model based on the AHP\textsuperscript{[3]}, Chen Jing and Wang Pengfei (2009) in light of the three big functions of the education, the scientific research and the social service have constructed the university core competitiveness appraisal system.\textsuperscript{[4]} At a new perspective the paper is an attempt from the angle of self-organization theory to research about the mechanism of self-organization evolution of university core competence construction engineering system with a view to Strengthen the university core competence engineering construction and provide one beneficial thought and a method for improving the Chinese University's core competence.

2. The Constituent Elements and Structural Model of University Core Competence Construction Engineering

Looking from the course of the university system evolution and the growth, the university system functions are changing from sole to the diverse development, the university core competences' content is also increasingly rich. But at present according to its functions of the personnel training, the scientific research and social service and the systematic engineering approach, the university core competencies mainly stem from university's resources gain and the conformity ability attribute, the personnel training ability attribute, the scientific research ability attribute, the educational reform and innovation ability attribute, the social service ability attribute as well as the management innovation ability attribute six aspects. So university core competencies are composed of six essential elements and university core competencies construction engineering consists of six big construction engineering elements. They are resources gain and conformity ability engineering, the personnel training ability engineering, the scientific research ability engineering, the educational reform and innovation ability engineering, the social service ability engineering and the management innovation ability engineering. The university resources gain and conformity ability engineering attribute responded through its resources gain and conformity ability engineering dimension whose personnel training ability engineering attribute responded through the personnel training ability engineering dimension, whose scientific research ability engineering attribute responded through the scientific research ability engineering dimension, whose educational reform and innovation ability engineering attribute responded through the educational reform and innovation ability engineering dimension, whose social service ability engineering attribute responded through the social service ability engineering dimension, whose management innovation ability engineering attribute responded through management innovation ability engineering dimension\textsuperscript{[5]}.

2.1. Resources Gain and Conformity Competence Engineering

Resource acquisition and integrated competence mainly refers to the university having the ability to research and develop, to apply, to integrate and extend the resource elements. It mainly includes the ability to acquire and integrate physical resources such as land, school site, fund, equipment and so on; It also includes the ability to acquire and integrate the human resources such as high quality students and outstanding talent. Strengthening the resources gain and the conformity ability engineering construction is the efficient path to enhance the resources gain and conformity ability.

2.2. Personnel Training Competence Engineering

Training personnel is university's basic task. The enhancement of personnel training quality is the symbol of university growth. Personnel training competence mainly refers to the university having ability to mold the personal character, to develop the intelligent, to instruct the knowledge, promote the quality to the talented person element. It mainly includes the quality, the specification, the scale and the structure of the personnel training. Strengthening the personnel training ability engineering construction is the efficient path to enhance the personnel training ability.

2.3. Educational Reform and Innovation Competence Engineering

Teaching is the inherent function of university and is the reason which the university exists. The educational reform and innovation competence mainly refers to the university having the ability to explore, to integrate, to reform and to innovate to a teaching element. It mainly includes the curriculum reform, the discipline construction, the teaching method innovation and teaching media innovation ability. It mainly manifests in the teaching manner, the teaching level, teaching art, the teaching effect and the degree of student satisfaction with teaching and so on.
Strengthening the educational reform and innovation ability engineering construction is the efficient path to enhance the educational reform and innovation ability.

2.4. Scientific Research Competence Engineering

The scientific research is one of university's main tasks. Scientific research competence mainly refers to the university having the ability to explore, to discover, to invent and create to a science element. It mainly includes the basic study (natural sciences and the social sciences), the applied research and development research ability. It mainly manifests in research funding, scientific research item, scientific research paper, scientific research monograph, achievements in scientific research, science and technology reward and so on. Strengthening the scientific research ability engineering construction is the efficient path to enhance the scientific research ability.

2.5. Social Service Competence Engineering

Social service is an important milestone in the course of the university growth and is the sublimation once again of university idea. The social service competence mainly refers to the university having the ability to excavate, to reform, to integrate and delay to social service element. It is mainly that the university provides the knowledge popularization, personnel training and scientific innovation serve for the society with its own teaching, information, intelligence and technical resources. It mainly includes the scientific and technical payoffs transformation, the adult education, the combination of production, study and research, strategic alliance, a variety of consultation service and so on. Strengthening the social service ability engineering construction is the efficient path to enhance the social service ability.

2.6. Management Innovation Competence Engineering

Management is also one kind of productive forces. Management energy is the order parameter or negative entropy flow that impels the university system evolution and university growth. Management innovation competence refers to the university having the ability to development, to process, to organize, to communicate and integrate to management element. It may be subdivided into strategic management, human resources management, scientific research management, teaching management, knowledge management, student management and cultural management innovation ability and so forth. Strengthening the management innovation ability engineering construction is the efficient path to enhance the management innovation ability.

3. The Evolutionary Mechanism of University Core Competence Construction Engineering Self-organizing System

3.1 The Self-organizing Characteristic of University Core Competence Construction Engineering Self-organizing System

The university core competence construction engineering system is an open complicated system with being far away from the equilibrium state, having the small fluctuation and the misalignment function mechanism. Under the management innovation energy's function, the system can be caused to move from the seal toward the opening, to transit gradually from near equilibrium state to be far away from the balanced condition, when the management innovation energy poured into achieves certain threshold value, through the fluctuation enlarge. It possibly causes the university core competence system phylogeny non-equilibrium phase changes, transforms from a chaotic disorder's state to a order state of the structure or the function. That is the state of the “dissipative structure”. The dissipative structure state of the university core competence construction engineering system can be maintained by unceasingly injecting the management innovation energy. Under the interaction of the structure, the function and the fluctuation, the university core competence construction engineering system's energy level will be promoted unceasingly. When the poured management innovation energy enlarge, the system on the basis of the existing dissipative structure condition possibly forms the new dissipative structure. Namely in the original energy level's dissipative structure jumps to the new dissipative structure branch so as to realizes the dissipative structure evolution. This will impel the university core competence construction engineering system to move from the
disorder toward the order, to move from the low order toward high order, to move from high order toward non-balanced chaos.\cite{6}\cite{7}\cite{8}

\section*{3.2 The Mechanism of Self-organizing Evolution of University Core Competence Construction Engineering System}

The formation and the evolution of the university core competence construction engineering self-organizing system are the result of the premise of each other, the interaction, the mutual cooperation among its interior various subsystems. According to the university core competence six strength engineering dimension structural model, we may establish the following system dynamic engineering model:

\begin{align}
\frac{dS}{dt} &= -k_1 \cdot S + \beta_1(M, C, P, T, A, B) + F \\
\frac{dM}{dt} &= -k_1 \cdot M + \beta_1(M, C, P, T, A, B) \\
\frac{dC}{dt} &= -k_2 \cdot C + \beta_2(M, C, P, T, A, B) \\
\frac{dP}{dt} &= -k_3 \cdot P + \beta_3(M, C, P, T, A, B) \\
\frac{dT}{dt} &= -k_4 \cdot T + \beta_4(M, C, P, T, A, B) \\
\frac{dA}{dt} &= -k_5 \cdot A + \beta_5(M, C, P, T, A, B) \\
\frac{dB}{dt} &= -k_6 \cdot B + \beta_6(M, C, P, T, A, B) \\
\end{align}

In above model, M, C, P, T, A, B and S represent separately university's management innovation competence, social service competence, scientific research competence, educational reform and innovation competence, personnel training competence, resources gain and integrated competence and the university core competence. k1, k2, k3, k4, k5 k6 and k represent separately the relation between the changing rate of M, C, P, T, A, B and S and its original state. \beta_1, \beta_2, \beta_3, \beta_4, \beta_5, \beta_6, \beta_3 represent separately that the effect of the university system stochastic fluctuation external force on the synergism's function among its 6 strength engineering dimension the M, C, P, T, A, B leads to the change of M, C, P, T, A, B and S.F represents the influences of the stochastic fluctuation external force on the change of the university core competence. And t represents the time. The equation (1) has indicated the university core competence evolved rule along with the time variation. The equation (2) has indicated the university management innovation competence evolved rule along with the time variation.

Equation (3), equation (4), equation (5), equation (6), equation (7) have the same meaning as equation (2). The university core competence is the product generated by 6 strength engineering dimension coordination with great uniqueness, heterogeneity, being difficult to imitate and relative stability. But the 6 strength engineering dimension's improvement reacts on the university core competence, whose change will urge the university core competence subsystem's secular variation, then they control university core competence system's evolution and development.

The university core competence' nonlinearities change may be indicated by using the following equation of motion:

\begin{align}
\frac{dS}{dt} (g-k)S - \beta S^3 + F = 0
\end{align}

And the k represents the relationship between the changing rate of university core competence and its original state. the g indicates controlling parameter that urges the system evolves the $-\beta S^3$ expressed the university core competence' misalignment function. F represents the stochastic fluctuation external force\cite{9}.

The potential function of university core competence may be represented as follows:

\begin{align}
\psi(S) = \frac{k-g}{2} \cdot S^2 + \frac{\beta}{4} S^4 - FS
\end{align}

This function curve shape is determined by the quadratic coefficients. The stable point of the s is equal to the minimum spot of the $\psi(S)$.But the maximum value spot of the $\psi(S)$ is the system's non-steady state. It is very easy for us to discuss system's structure with a small ball's movement in potential function. When F=0, as for the different g, k value, the shape of potential function is different. The influence of the $\psi(S)$ shape on the stability can be understood as its binding force to the small steel ball. As for different g, k value, the shape of potential function shows in Figure 1.

When g<k the binding force to the small steel ball is the largest. And when g=k ,while as for S=0, it is stable. but as long as there is a little perturbation to the small ball ,it will take a longer time quiet down the oscillation .This is because the binding force of the potential function to the small steel ball is smaller than that of the potential
function to the small steel ball when the $g<k$. Moreover, when $g=k$, it happens to the critical point, this situation has
the generality, namely when the stable state changes, at first it will reduce the antijamming ability, thus aggravating
amplitude of oscillation. This kind of phenomenon will be called the critical slowing phenomenon. When $g>k$, the
potential function has the function curves of $\pm \sqrt{g-k}$ two stable states. As for $s=0$, it is the unstable state. It is
envisaged that a small ball in the shape of the potential function is shown in Figure 1, where will the small ball stop?
Theoretically it may stop in the zero point, but any disturbance to the small ball will cause it to leave the zero point,
And it can stay at the place of both $\sqrt{g-k}$ and $-\sqrt{g-k}$, where will the small ball stay in the end? In fact this situation
precisely is the choice of the symmetry breaking that has appeared in the dissipative structure.

In the university core competence construction engineering system the change of some engineering dimension
strength can promote the university core competence to evolve. Since the difference of the various engineering
dimensions strength's change and its speed will cause the different coordination result, this will cause the evolved
direction of the university core competence exist the choice of the multiple paths. In particular after some
engineering dimension strength (or many kinds of dimension strengths) has changed, it is possible to produce a state
of university core competence in the role of self-organization. As a result the potential function has presented the
dissymmetry.

Generally, when $g, k$ is fixed, the extreme point of the $v(S)$ is taken as the function of the $F$ and its relations is
shown in Figure 2. When $F \in (-\infty, F_1)$ it has a stable state. When $F \in (F_2, +\infty)$ it also has a stable state. But
when $F \in (F_1, F_2)$, it has three stationary states, two of which are stable states, whose corresponding potential
function is shown in Figure 3.
With the change of \( F \) from small to big, the potential function is in turn followed by \((a) \rightarrow (b) \rightarrow (c) \rightarrow (d) \rightarrow (e)\) in which it occurs to a small ball having definitely jumped change at a moment, namely that the mutation of the system structure. Pay attention to the region of the three steady state. The binding force of the two steady state to the small ball is not different. It is envisaged in the chart that skipping to B from A and skipping to A from B pays the energy asymmetry. It is believed that B is more stable. Which stable state may be realized in the end? Regarding this, there are two customs to decide the choice: If the system had ability to find the most stable state to realize, it is known as the Marx well custom; If the system looks for the most approaching stable state to realize, then it is called the ideal lag custom. Figure 4 is the response path of the ideal lag custom to the branch chart (Figure 2). Figure 5 is the response path of Marx well custom to the branch chart (Figure 2).

The dissipative structural theory and the synergetics have promulgated one kind of universal law from the old structure to the new structure process which is nearly any system structure transformation process to follows. When instability of the old structure has occurred under the outside parameter function at first some few parts of macroscopic variables lose the stability, but minority several variables without loss of the stability are controlled by a few of several variable with loss of the stability. The system's structural change is decided by the minority several order parameter.

4. Conclusions

Under the general trend of education informationization, modernization and globalization the core competencies are the foundation of university's survival and development. So how to improve its core competence will be the topic which each university superintendents must reply. this paper thinks university core competence construction is a systematic engineering and Strengthening the university core competence engineering construction is the efficient path to enhance the university core competence. Hence at first in this paper its constituent elements and structural model has been explored by means of systematic engineering approach. Then the university core competence construction engineering system has been analyzed by utilizing self-organization theory, it has been discovered that it has self-organization characteristic. It is an opening and far away from the equilibrium state system with the existence small fluctuation and the non-linear interaction mechanism. And it has six subsystems such as resources gain and conformity competence engineering, personnel training competence engineering, educational reforms and innovation competence engineering, scientific research competence engineering, social service competence engineering and management innovation competence engineering. Finally, the paper believes that the university core competence construction engineering self-organization system has the following evolution mechanism: When the university core competencies construction engineering system is in the original stable state, Under the management innovation energy's function a few parts of variables lose the stable. As a result the system will be unstable, presenting the bifurcation phenomenon namely presenting many branches. When the management innovation energy poured into achieves certain threshold value, because of university stochastic fluctuation external force it will cause the core competence system to have a small deviation from the system integrity, and will be enlarged rapidly through the internal 6 strength engineering dimension self-organization movement to form the great
fluctuation. It can lead to the formation of university core competence construction engineering systematic dissipative structure. Its dissipative structure state can be maintained by unceasingly injecting the management innovation energy. The university core competence construction engineering system may realize the stable state by Maxwell custom or the ideal lag custom. When the poured management innovation energy is enlarged, the six strength engineering dimension synergism's result enables the university core competence construction engineering systematic dissipative structure jump to the new dissipative structure branch. Then it will impetus university core competence construction engineering system from disorder to order, from low order to high order as well as from high order to non-balanced chaos evolution.

In a word, from macroscopic perspective this paper combines the systems engineering method and self-organization theory with the university core competence engineering construction to have established the university core competence six strength engineering dimension structural model and its system dynamic engineering model in order to provide the beneficial thought and the method for the discussion of the evolving mechanism of university core competence engineering construction self-organization system.

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