

Application of Complex Adaptation System Theory in Construction of Private Higher Education Institutions

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Abstract—According to the complex adaptation system, the construction system of private higher education institutions is constructed to solve the problem of the development and construction of private higher education institutions. This paper analyzes the characteristics of complex adaptation system, and argues that private higher education institutions are a typical complex adaptation system. According to the modeling and simulation idea of "bottom-up" of complex adaptation system theory, the main frame of the construction model of private higher education institutions based on subject is designed, and the function of complex adaptation system theory in the construction of private higher education institutions is expounded, which can improve the construction level of private higher education institutions.

Keywords—Complex Adaptive System Theory; Private higher education institutions; Model; Application

I. INTRODUCTION

After more than 30 years of precipitation and accumulation, private higher education in China has gradually matured. With the promotion of educational modernization, more and more private higher education institutions pay more attention to the quality of personnel training, and take the construction of first-class applied undergraduates as the goal of their development and construction. According to the National List of Colleges and Universities recently published by the Ministry of Education, a fact is that "as of June 15, 2019, there were a total of 2956 institutions of higher learning in the country, of which 2688 were ordinary institutions of higher learning (including 257 independent colleges and universities) and 268 were adult institutions of higher learning." There are 434 private higher education institutions, 17 more than that in 2017. It can be seen that private higher education institutions have become a new growth point of national higher education and an important part of higher education in China. With the development of modern science and technology, especially artificial intelligence, big data, block chain technology in the field of education, the development and construction of private higher education institutions, it is urgent to solve the problems of unstable teaching staff, declining number of students, low quality of talents training, and so on.

Most of the private higher education institutions run schools with more than 10,000 people, and their teaching conditions are becoming better and better, the comprehensive quantity education is becoming better, and all kinds of

information gather and set up a large number of data, which bring a lot of problems against the management and construction of colleges and universities. The Theory of Complex Adaptive System is an important part of system engineering, which has been applied in many fields. The construction and management of private higher education institutions is of a high degree of complexity, education and teaching to multi-dimensional development, involving complex content, which has initially become a typical complex adaptation system. The application of the Complex Adaptive System Theory in the education and teaching of private higher education institutions will open up a new way to the study of the construction and development of private higher education institutions.

II. BRIEF INTRODUCTION TO THE THEORY OF COMPLEX ADAPTIVE SYSTEM

With the deepening of the research on complex systems in the field of system engineering, Holland, founder of the genetic algorithm, formally put forward the Theory of Complex Adaptive System (Abbreviated CAS) in 1994. Its core idea is that adaptability makes complexity, that is, the agent in the system can communicate with the environment and other agents, and "learn" or "accumulate experience" from it. In the process of continuous evolutionary learning, at the same time, it also reacts on the environment and promotes the change of the environment, thus increasing the complexity of the system. The "agent" here refers to the adaptive, active agent in the system, which can modify their own behavior rules according to the behavior effect, in order to better survive in the objective environment.

A. Basic characteristics of the Complex Adaptive System

Individuals in complex adaptive systems are generally called elements, parts or subsystems. There are seven basic characteristics of this system, of which the aggregation, non-linearity, flow and diversity are the four characteristics of individual attributes, which will play a role in adaptation and evolution. Tagging, internal model and building blocks are the mechanism and related concepts of communication between individuals and the environment.

1. Aggregation. It is clear that individuals form large multi-agent aggregates by "bonding", which can act like a single individual in the system.

2. Non-linearity. When individuals and their attributes change, they do not follow a simple linear relationship, but actively adapt to it.

3. Flow. There are matter, energy and information flow between the individual and the environment, which directly affect the evolution of the system, and the key role of which is the information flow.

4. Diversity. In the process of adaptation, for various reasons, the differences between individuals will develop and expand, and finally form differentiation.

5. Tagging. In order to identify and select each other, individual identification plays an important role between individual and environment, and the function of identification is mainly to realize the exchange of information.

6. Internal models. Individuals have complex internal mechanisms, which are collectively called internal models for the whole system and provide the ability to pre-process the system.

7. Building blocks. Complex systems are often formed by changing the combination of relatively simple parts.

B. Advantages of the Complex Adaptive System Theory

CAS theory has the following advantages and characteristics compared with traditional system analysis methods:

1. Initiative. The traditional system method is not enough to consider the initiative of the individual, so it is difficult to describe and study the large-scale complex system. While the CAS theory takes the initiative of each element in the system as the most fundamental source of power for the development and change of the system, thus to provide ideas for understanding and controlling the large-scale complex system.

2. Hierarchy. Because the CAS theory recognizes the relativity of hierarchy, it has a new understanding of hierarchical problems, and can dialectically look at and deal with the relationship between macro and micro, and fully consider the two sides of things. This theory can deeply study and observe complex systems from different levels, which increases the flexibility and breakthrough of research.

3. Dynamic. Compared with the traditional system method, the CAS theory can fully consider the evolution process of the system and regard the state of the system as a link or result of the evolution process, thus to provide the possibility for understanding the complexity of the system and controlling the complex system.

4. Maneuverability. The traditional system analysis method is difficult to implement and operate because of the lack of available data or the complexity of calculation. The CAS theory provides a variety of computer simulation platforms, which makes it possible for researchers to carry out practical operation.

C. Private higher education institutions are typical complex adaptive systems

The modern educational concept requires universities to focus on students and carry out education and teaching around the training of talents and the development of school construction. Private higher education institutions have gradually formed a complex system with huge system and complex management. According to the characteristics of complex adaptation system, it can be seen that private higher education institutions are a complex adaptation system.

Firstly, private higher education institutions must rely on the information system to build a large management system. The system here includes information system, which is composed of various educational and teaching elements, units and systems. From the point of view of entity structure, the construction of private higher education institutions can be regarded as composed of information service system, decision management system, teaching management system, teacher system, scientific research system, student system, service guarantee system, ideological education system and so on.

Secondly, the interaction between the elements of the construction system of private higher education institutions and their interaction with the environment is complex and diverse. As an element of the system, the development and evolution of a single subsystem is greatly affected by the background of the times and the development and evolution of other subsystems, and the elements interact with each other, thus forming a complex and diverse evolution form.

Thirdly, there are many uncertain factors in the education and teaching system of private higher education institutions, which lead to the uncertain results of the state evolution of the system, which is full of inevitable contingency.

Fourthly, the construction of private higher education institutions has the characteristics of four complex adaptive systems: self-organization, self-adaptation, co-evolution and rapid equilibrium. Self-organization allows the education and teaching of private higher education institutions to sum up experience and produce new concepts and new education and teaching system on the basis of the interaction of each agent; adaptively let each subsystem of education and teaching always update and adjust its own function and its relationship with other subsystems constantly; each subsystem can carry on the common evolution and the rapid equilibrium.

III. MODELING OF CONSTRUCTION SYSTEM OF PRIVATE HIGHER EDUCATION INSTITUTIONS BASED ON THE CAS THEORY

The CAS theory provides a "bottom-up" or "process-based" modeling and simulation research method, through which the main bodies and environment of complex systems can be simulated, in order to predict the development trend and evolution results of the system. Warm is a kind of software platform specially designed and imitated for complex adaptive systems with the development of complex adaptive system theory. Its core is to provide an object-oriented framework to study the behavior of adaptive agents and other objects that interact in the simulation system.

A. The system composition of private colleges and universities

The biggest difference between private colleges and public colleges and universities lies in the governance of legal persons and the source of funds. Private higher education institutions have boards of directors, and the organizers (investors) are mostly chairman or chairman of the board of directors, and thus they have a strong enterprise nature. In the process of running a school, its own internal operation mechanism has been gradually formed, which is the process, principle and mode of interaction among the internal elements of private higher education institutions, as well as the basic norms and corresponding systems of various activities related to people, money, things and so on. From a macro point of view, the internal management of private higher education institutions can be divided into enrollment and employment management, teaching management (teaching operation mechanism), scientific research management (scientific research operation mechanism), political management (power operation mechanism), and other parts.

Around the internal management and school development and construction, the construction management of colleges and universities will be divided into different systems. Firstly, the management decision-making system, which is the leadership of private higher education institutions, with the chairman as the core, determines the development and construction of the school. Secondly, the student system, including enrollment, employment and student management, is the key to the existence of the school. Thirdly, the educational administration management system, which is responsible for daily teaching, professional construction and other related contents related to personnel training, can reflect the teaching level and reputation of running a school. Fourthly, the teacher system. Teacher training of private higher education institutions determines the development prospect of the school. Fifthly, the scientific research system. Scientific research and teaching complement each other, and if there is no matching scientific research, there will be no high-level universities. Sixthly, the service support system, including logistics support and equipment management, which is the strongest sense of experience for students and teachers. Seventhly, the ideological education system, which includes the ideological education of students and teaching staff, acts as the guarantee for adhering to the direction of running a socialist school. Only when these systems cooperate

and complement each other, can we have new educational and teaching abilities, and improve the level of running and running schools in an all-round way through the adaptive and self-synchronization of each subsystem realized by information sharing.

B. Construction model of colleges and universities based on the CAS Theory

Based on the CAS theory, the subsystems of private higher education institutions are regarded as an agent, and the elements are regarded as an agent in each subsystem. On the basis of the main body model, the macro model of the whole university construction is established. The agent model is the basic model, and the agent can communicate, save and process resources with other agents. The resources in the macro model include information resources, educational resources, human resources and so on. The basic situation of the agent is shown in figure 1. The attack mark is used to actively contact with other agents; the defense identification is used to decide whether to respond or not when other agents contact themselves; and the resource base is used to store processing resources.

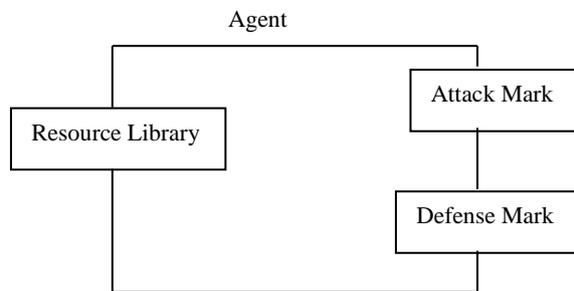


Fig.1 The basic situation of the agent

Based on this idea, the system model of each subsystem is established. In the subsystem, the combat unit and elements are defined as the main body, the energy, information and other resources can be exchanged between the main bodies, and the resources can be reorganized and regenerated. Its structure is shown in figure 2:

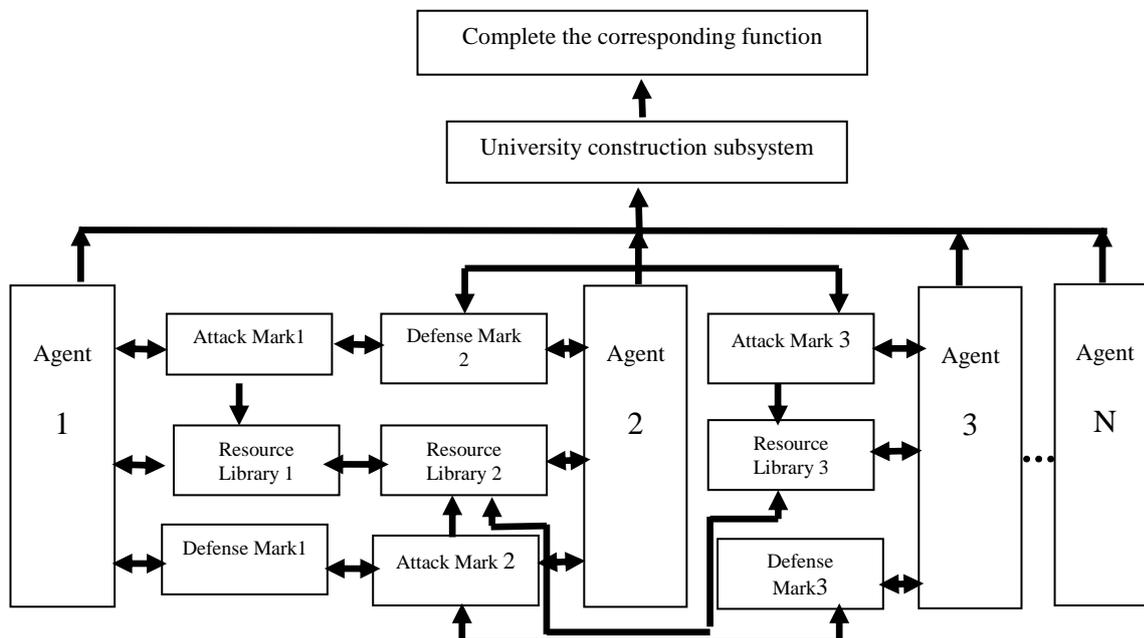


Fig.2 Modeling Architecture of Subsystem

On the basis of establishing the subsystem, the university construction system is established. Each subsystem is the main body, and can carry on the energy exchange. The interaction of energy and resources can be carried out between the main bodies, which is adaptive and can give full play to the energy efficiency of each system. Its structure is shown in figure 3.

After the establishment of the model, the internal resources of each subsystem can be reorganized and self-improved, and the subsystems can carry out resource exchange, information fusion, improve the level of education and teaching, and finally improve the overall ability of running schools in private colleges and universities.

IV. CONCLUSION

The education and teaching in private higher education institutions is a typical complex adaptive system. The traditional linear reductionism analysis method can no longer meet the needs of analysis and research education and teaching. Using the Theory of Complex Adaptation System to solve the problems encountered in the construction and development of private higher education institutions will be an important research content for private education practitioners, improving the student-centered talent training ability, making the departments of private higher education institutions highly integrated and adaptive, and realizing scientific and efficient management.

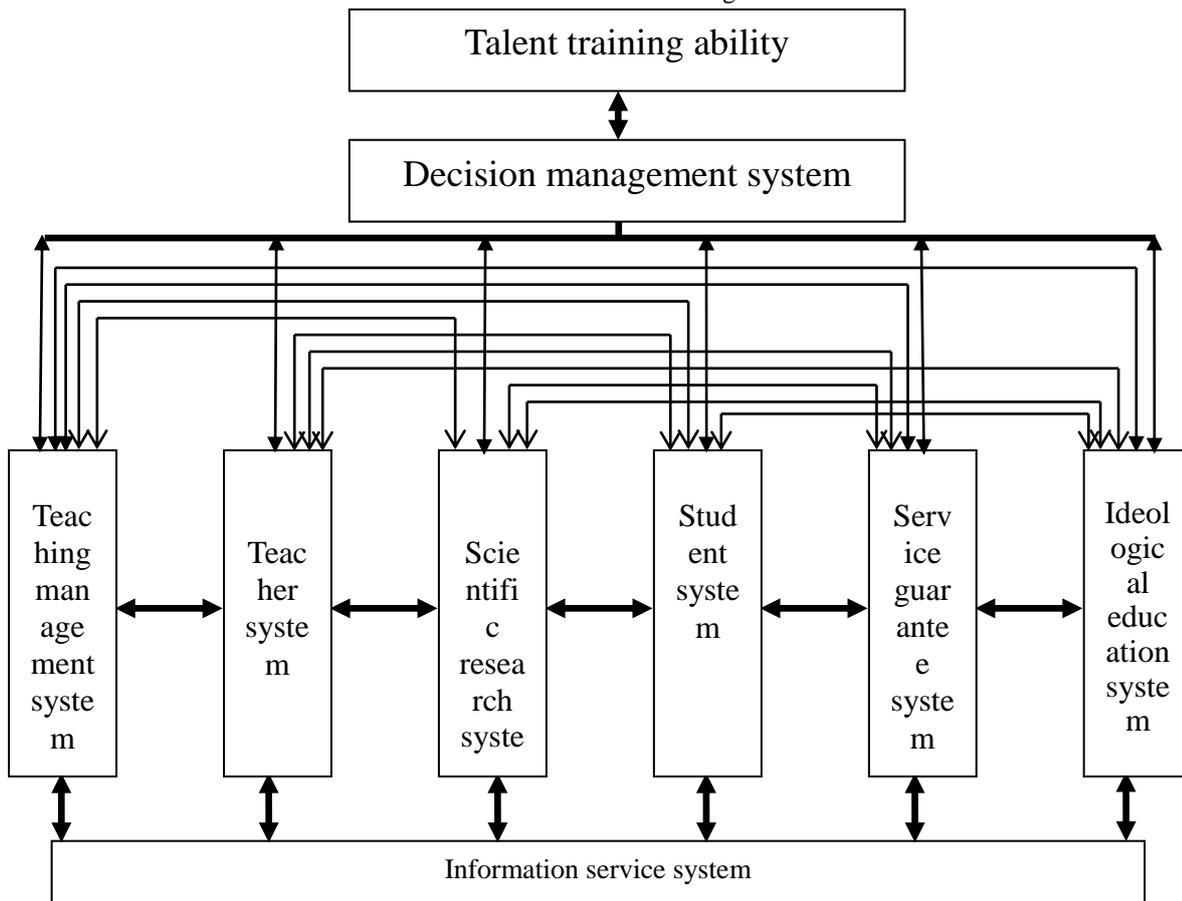


Fig.3 Modeling framework for university construction

REFERENCES

[1] http://www.moe.gov.cn/jyb_xxgk/s5743/s5744/201906/t20190617_386200.html

[2] LCDR Kevin P. Schaaff, Warfare as A Complex Adaptive System [J],IEEE:1996

[3] Wang Yingluo. Systems Engineering (third Edition) [M], Beijing: Machinery Industry Press,2003 : 40-54(In Chinese)

[4] Liao Shouyi, Dai Jinhai. Complex adaptive system and modeling and simulation method based on Agent [J]. Journal of system Simulation,2004,16(1):113-117(In Chinese)

[5] Xu Xuqing. Core Concerns on Development of Private Higher Education Institutions under the New Normal [J],Chinese higher education research,2016(2):67-69(In Chinese)

[6] BIE Dun-rong. On the Meaning of Market Mechanism to Private Institutions of Higher Education [J],Journal of Higher Education, 2010(4):71-77(In Chinese)

[7] Kang Zhao,Zhiya Zuo,Jennifer V. Blackhurst.Modelling supply chain adaptation for disruptions: An empirically grounded complex adaptive systems approach [J],Journal of Operations Management,2019:190-212