Dynamics Modeling and Simulation of System Catastrophe in Knowledge Collaboration Complexity Network

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Abstract—**Knowledge collaboration network is a kind of complexity network. System catastrophe phenomenon will appear in the knowledge collaboration complexity network in some condition, and the whole system will became low-efficiency or inefficiency. Based on the analysis of catastrophe phenomenon in the knowledge collaboration complexity networks, this paper proposed a catastrophe model. Using with the dynamics simulation tool VERSIM, a dynamics model of catastrophe phenomenon in the knowledge collaboration complexity network is built. Moreover, simulation results are given, which disposed reasons of catastrophe phenomenon in the knowledge collaboration complexity network.**

Index Terms—**knowledge collaboration, system catastrophe, complexity network, dynamics modeling and simulation**

I. INTRODUCTION

Knowledge collaboration exists commonly in global research and development network, knowledge alliance crossing many organizations' boundary, or business operation network [1-4]. Knowledge collaboration is based on a certain complexity network including many knowledge individuals. So, as the most microcosmic organization form, knowledge collaboration complexity network is seen as a relationship network among many knowledge collaboration partners. Knowledge used or created in knowledge collaboration procedure flows from one net node to another one [5], so that knowledge is transported or shared. In knowledge collaboration complexity network, each node represents a knowledge collaboration partner. The relationship between any two partners is one of three cases: unilateral collaboration relationship, bidirectional collaboration relationship or none collaboration relationship.

Catastrophe phenomenon often occurs in a system with network structure [6]. In a system, resources can be utilized in two different styles: efficient style or inefficient style. For maximizing the system resource utilization, activities of system users must switch dynamically between the two styles of efficient utilization and inefficient utilization. If the style of inefficient utilization has not affected other users, system resource isn't wasted completely. But, if the ratio of inefficient utilization reaches a certain critical value, the whole system efficiency will suddenly decrease, therefore, the catastrophe phenomenon appears. For example, such catastrophe phenomenon often occurs in telephone service system. Catastrophe phenomenon is a kind of mutation phenomenon because of asymmetry. In fact, the catastrophe phenomenon is arose because of some key system parameters approach their critical value. However, some systems with self-adaptive capability can reach a new equilibrium by self-recovering, and the system will enter into a new more efficient state.

Obviously, catastrophe phenomenon occurs in a knowledge collaboration complexity network. How to know these critical values of some key system parameters? How to switch between efficient utilization and inefficient utilization without restraining the whole system? We will try to answer these questions by simulation of catastrophe phenomenon in knowledge collaboration complexity network.

II. CATASTROPHE PHENOMENON IN KNOWLEDGE COLLABORATION COMPLEXITY NETWORK

A. Knowledge Collaboration Complexity Network

Knowledge collaboration is an interactive procedure of knowledge activities, in which many partners participate, and aims for optimizing and integrating knowledge resources and enhancing knowledge capacity of knowledge innovative tasks in organizations with the help of the theory of synergy, advanced information technologies and modern management methods.[7,8] Knowledge collaboration realizes the integration of technical functions and management functions so as to improve obviously the operation of the enterprise's knowledge assets in aspects of operational costs, quality,

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service and speed. Here, the organizational knowledge ability refers to the ability of operating knowledge resources, which is the integration of many abilities including knowledge absorbing ability, knowledge transfer ability, knowledge updating ability, knowledge application ability, and knowledge innovation ability and so on.

Based on the definition of knowledge collaboration, knowledge collaboration possesses the following characteristics: 1) Knowledge collaboration is innovation-oriented; 2) The task of collaboration is knowledge-intensive; 3) Collaboration partners are complementary in knowledge with each other; 4) The effect of collaboration is win-win.

In operation environment of real organizations, the operation of knowledge collaboration and the realization of collaboration effect is based on a suitable knowledge network. Namely, the knowledge coordination needs a new organization pattern as the foundation, which is called knowledge coordination network. In fact, this kind of network is a relationship network among multi organizations, multi departments or multi staff, on which knowledge flows from one node to another, so, knowledge sharing and transferring is realized. These nodes may be organizations, departments, staff even or software containing knowledge, which also can be seemed as a special partner. A pattern of knowledge collaboration network is shown in Fig. 1. Each small circle represents a node, and also expresses a partner. Each partner of the knowledge collaboration network not only has the natural attributes, such as domain knowledge capacity, knowledge ability of using sharing methods, knowledge absorbency ability and so on, but also has some relative attributes, which mainly is knowledge collaboration degree between each pair of partners. Since, there are relations in any pair of partners in the knowledge collaboration network. And, the relationship of partners is non-directional. So, knowledge coordination network should be an entire connection non-directional network.

Partners in knowledge collaboration network not only carry out individual activities with its own natural attributes, and moreover promote knowledge value through knowledge exchange and knowledge sharing and transferring among partners.

Knowledge collaboration complexity network is a kind of resource operation system. In some special status, catastrophe phenomenon will appear in it. And, catastrophe will make the whole system efficiency decreases rapidly, not only the collaboration effect will lose, but also it may damage organizational innovation capacity and continuable dominance, and even damage existence of the knowledge collaboration complexity network.

B. Catastrophe Phenomenon

In knowledge collaboration complexity network, catastrophe phenomenon exists four kinds of cases as following:

(1) Excessive knowledge supply

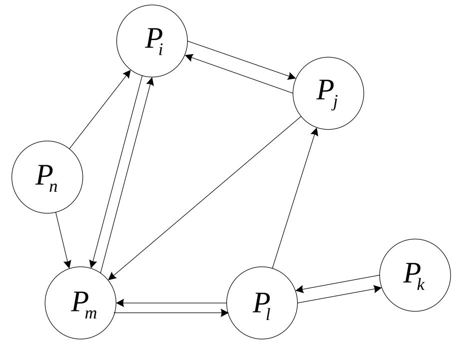

Figure 1. A pattern of knowledge collaboration network

The Internet not only brings globality to the world’s economy, but also leads to global knowledge integration. By using with computer networks, acquirement of knowledge is easier than ever before. Especially, abundance and various forms of knowledge make organizations to fall into a predicament of ‘knowledge explosion’. Under the influence of knowledge management theory, organizations believe increase of knowledge could be taken as major object. Furthermore, global network makes it easily to acquire more and more knowledge. Unfortunately, a beneficial regenerative loop ‘learning -- knowledge increasing -- income increasing -- further learning -- (next loop)’ haven’t taken shape in most of organizations. Whole staff participating organization learning cost a large amount of organizational resource, but bring less organization performance increment [9, 10].

(2) Low-efficiency of knowledge collaboration paths

Knowledge collaboration paths are same as telephone lines in telephone system. As a kind of resource, it’s quantity is limited for a knowledge collaboration especially in a procedure of knowledge collaboration with tight time and heavy task. In addition, because the structures of some social networks are not good or contain many bridges or tangential points, collaboration paths will be in short in some locals, furthermore, which lead to a global phenomenon of .low efficiency of knowledge collaboration. Thereby, for knowledge collaboration teams, if an automatic configuration mechanism is absent in the knowledge collaboration complexity network, the whole efficiency of knowledge collaboration complexity network increases rapidly [10,11].

(3) Absence or irrationality of inspiring mechanism

Absence or irrationality of inspiring mechanism may lead knowledge collaboration partners to shape into a pattern of being eager for quick success and instant benefit, which will prompt collaboration partners to quit the high-cost style of knowledge collaboration, such as knowledge innovation, and to centralize some low-cost style of knowledge collaboration, such as knowledge reusing, and it will lastly result in the low efficiency pattern of knowledge collaboration. Besides, ‘hitch-hiking’ phenomenon may be another sequel of absence inspiring mechanism.

(4) Relatively shortage of resources

When organizations hunt for more and more knowledge innovation, staff will demand more and more resources. If the increasing rate of system's resources is lower than the demand increasing rate, then multiplier effect of cost asymmetry will be intensified, lastly, the global efficiency of system will flutter fading. For example, some firms have dropped into 'Research & Development's investment Trap' for maintaining the strategic advantage.

Obviously, all of above reasons may result in the catastrophe phenomenon, and the knowledge collaboration complexity network will fall into a low efficiency or inefficiency status. So, we need analysis the phenomenon and cast about for the key influencing factors before these problems are solved.

In following sections, we will build a catastrophe model and then study the phenomenon theoretically.

III. The Catastrophe Model of Knowledge Collaboration Complexity Network

The knowledge collaboration relationship can be seen as a special cost-profit trade relationship, then, according to the method mentioned by references [6,12,13], the catastrophe model of knowledge collaboration complexity network can be built as following.

Knowledge supply-demand system of knowledge collaboration is shown in Fig. 2. Suppose that the knowledge collaboration complexity network is composed of M knowledge supplier S_i ($i=1,2,\cdots,M$) and N knowledge demander F_j ($j=1,2,\cdots,N$). For simplicity, each knowledge demander F_j has a settled knowledge collaboration relationship with only one knowledge supplier S_i. And, the collaboration efficiency between them is higher than the collaboration efficiency between F_j and any other knowledge suppliers, so, the collaboration efficiency will be lower.

At first, six hypothesizes are given as following:

(1) Knowledge supplier S_j will cost one unit resource to handle the knowledge demand of knowledge demander F_j, and will cost E units resource to handle the knowledge demand of knowledge demander F_k, and $k \neq j, E>1$. Because the settled knowledge collaboration relationship between S_j and F_j, their collaboration cost is lower than the E units collaboration resource of S_j and any F_k ($k \neq j$).

(2) Each knowledge demander F_j will require knowledge from S_j firstly. But, if S_j cannot provide knowledge in time, F_j will require other knowledge suppliers.

(3) Each knowledge suppliers handle knowledge demand at the velocity P. And, each knowledge suppliers share the knowledge demand averagely.

(4) All knowledge demand forms a continuous homogeneity flow at the velocity Q.

(5) Knowledge suppliers can publish knowledge anywhere at anytime through networks with less resource investment, and gain appreciable economic benefit, increasing individual reputation, higher trust and more social capital. Thereby, more knowledge suppliers will be willing to provide more own knowledge resources into the knowledge communities. Because knowledge has the character of sharing, these resources investment will not effect the investment in their fixed collaboration relationship.

Based on above hypothesizes, we proposed the catastrophe model of knowledge collaboration complexity network.

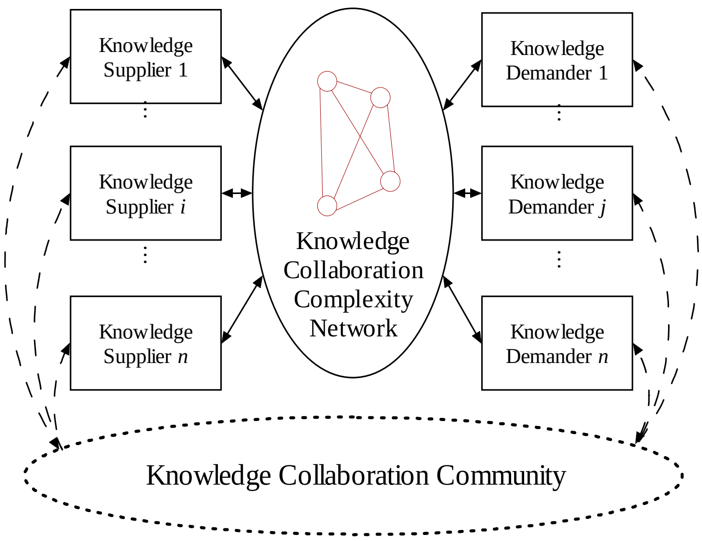

Figure 2. Knowledge supply-demand system of knowledge collaboration

Because of the procedure of knowledge collaboration, the demand velocity of knowledge demander is commonly lower than the handling velocity of knowledge supplier. If set $\delta = P - Q$, then $\delta > 0$. However, at the start point t_0 of knowledge collaboration, each knowledge supplier S_j received $P + \varepsilon$ knowledge demand from knowledge demander F_j, and the exceed amount ε will not be handled by S_j during the time t_0, so these tasks will be distributed to other knowledge suppliers.

If $U_j(n)$ denotes the amount of unhandled knowledge demand by S_j in time t_n, where, $n = 0,1,2,\cdots$, $j = 1,2,\cdots,J$. Then,

$$U_j(n) = \varepsilon \tag{1}$$

In the next time unit t_1, S_j accepts $1/(J-1)$ unhandled knowledge demand from each of other $(J-1)$ knowledge suppliers. So, S_j will accept $U_j(0)$ unhandled knowledge demand.

These unhandled tasks became the knowledge demand of the knowledge collaboration system (knowledge community), which will cost $U_j(0)E$ units system resource. And, since S_j has used its resource to satisfy the demand, it has only $P - U_j(0)E$ units resource to satisfy the demand of its immobility collaboration relationship. Because, each unit of knowledge demand of immobility collaboration relationship will cost one unit resource, so, at time t_1, the amount of uncompleted tasks of S_j will be

$$\begin{aligned} U_j(1) &= Q - (P - U_j(0)E) \\ &= U_j(0)E - \delta = \varepsilon E - \delta \end{aligned} \tag{2a}$$

At following time point $2,3,\cdots,n$, $U_j(n)$ varies as

$$\begin{aligned} U_j(2) &= U_j(1)E - \delta = (\varepsilon E - \delta)E - \delta \\ &= \varepsilon E^2 - \delta(E+1) \end{aligned} \tag{2b}$$

$$\begin{aligned} U_j(3) &= (\varepsilon E^2 - \delta E - \delta)E - \delta \\ &= \varepsilon E^3 - \delta(E^2 + E + 1) \end{aligned} \tag{2c}$$

$$U_j(n) = \varepsilon E^n - \delta(E^{n-1} + E^{n-2} + \cdots + E + 1) \tag{2d}$$

Moreover, $U_j(n)$ can be transformed as

$$U_j(n) = \varepsilon E^n - \delta \frac{(E^n - 1)}{E - 1}. \tag{3}$$

So,

$$U_j(n) = \frac{(\varepsilon(E^n - 1) - \delta)E^n + \delta}{E - 1}. \tag{4}$$

Where, $U_j(n) \ge 0$ and $U_j(n-1)E < P$.

As shown in formula (4), over-amount knowledge demand $U_j(n)$ increases exponentially. For the limitation of system resource, if $U_j(n)E \ge P$ occurs, at the time point t_n, system will try to consume all resource to satisfy all knowledge demand in the knowledge community. Then, catastrophe phenomenon will appear at the time t_n.

In the front analysis, we suppose that the velocity of handling knowledge demand always exceed the increasing velocity of knowledge supply, that is, $P > Q$. And, at the time t_0 there is an excess quantity of knowledge demand ε. Of course, in fact, it may be just the opposite, if we suppose that the excess quantity of knowledge demand ε is so small that $\varepsilon E < P$. Therefore, there are two cases:

(1) Non-catastrophe

When

$$\varepsilon(E-1) \le \delta \tag{5}$$

Obviously,

$$U_j(0)E = \varepsilon E < P \tag{6}$$

Thus, if $U_j(1)E$ is not 0, then

$$\begin{aligned} U_j(1)E &= (U_j(0)E - \delta)E \\ &= (\varepsilon E - \delta)E \le \varepsilon E < P \end{aligned} \tag{7}$$

Similarly, if $U_j(2)E$ is not 0, then

$$\begin{aligned} U_j(2)E &= (U_j(1)E - \delta)E \\ &= (\varepsilon E - \delta)E \le \varepsilon E < P \end{aligned} \tag{8}$$

Thereby, $U_j(n)E < P$. So, there are none catastrophe phenomenon.

(2) Catastrophe

When,

$$\varepsilon(E-1) > \delta \tag{9}$$

Obviously, $U_j(n) \ge 0$ at any time t_n. So, $U_j(n)$ increases with the exponential function of n. Therefore, $U_j(n)E$ will exceed P. System resources exhausted and catastrophe phenomenon occurs.

IV. Simulation Research

A. Simulation Procedure

Obviously, the catastrophe model of knowledge collaboration network is a kind of system dynamics model. Therefore, we will adopt system dynamics analysis method to research the catastrophe model. And, we can use some useful methods and tools to study the catastrophe model of knowledge collaboration network.

The procedure of system dynamics analysis method includes six steps:

(1) Analysis system, to analysis dynamic behaviors, characters and effective factors of the target system.

(2) Design a conceptual model for the dynamics system, and define all parameters of model.

(3) Build the simulation model of the dynamics system. Considering the simulation model cannot simulate the real system completely, so, some assumptions need be proposed before simulation.

(4) Simulate. By using some proper simulation research software system, we can simulate the dynamics system's behaviors on the computer expediently.

(5) Evaluate the simulation is whether completed. If yes, the procedure of system dynamics analysis method is end. Otherwise, we need to modify the simulate model or conceptual model, and simulate the model again.

Fig. 3 is the flow chart of the procedure of system dynamics analysis method.

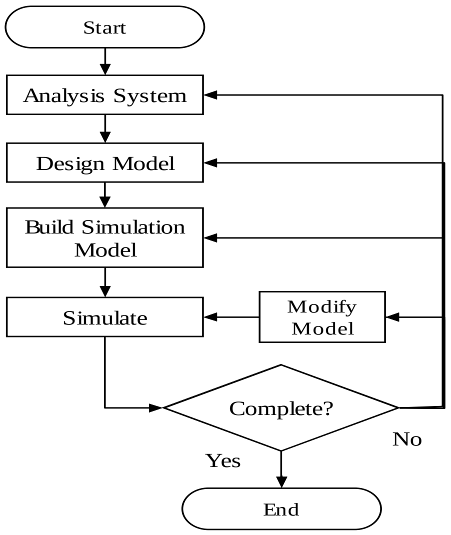

Figure 3. Procedure of system dynamics analysis method

B. Simulation Tool

In this paper, we use the system dynamics research tool VENSIM. VENSIM is one of several commercially available programs that facilitate the development of continuous simulation models known as system dynamics models. Compared with competing programs, VENSIM is extraordinarily powerful yet inexpensive [14,15]. As a kind of modeling tools, VENSIM can build conceptual, documental, simulation, analysis or optimization models of dynamic systems. It provides a simple, powerful and agile dynamic system modeling tool. Moreover, VENSIM provide a very effective, visible and friendly simulation environment. Furthermore, it's easy to analysis the simulation results completely in the simulation environment only with very simple operational procedure.

For simplifying the procedure of simulation dynamic models with higher order, nonlinear, multi-loops and time delayed, dynamics simulation method adopts a set of symbols representing differential equation in researching dynamic states changing situations. According to the conceptual model of dynamics system, cause-effect diagram, flow diagram, causes tree diagram, uses tree diagram and codes can be obtained in VENSIM. However, except for the cause-effect diagram, other model styles can be transformed from flow diagram. Therefore, flow diagram is the main model style if using VENSIM. A flow diagram in VENSIM will use five common symbols, including three variable types and two edge-types. The variable types are stock (also called level or state), the rate variable and Auxiliary/Constant. The edge types are information (which is represented as a connector edge of the type used in the causal loop diagram) and flow.

(1) Stock variable

It's also called as 'stock'. A stock variable represents a point where content can accumulate and deplete by the rate 'Rate'. So, it will be affected by the variable 'Rate'. So, the available resource quantity of knowledge collaboration network should be a stock variable.

(2) Rate variable

It's also called as 'rate'. A rate variable represents the changed value in a unit time, which maybe plus or minus meaning that the stock value is increased or decreased. For example, the knowledge the velocity of handling knowledge by knowledge supplier or the velocity of handling knowledge by knowledge demander should both be rate variables.

(3) Auxiliary/Constant variable

Auxiliary/Constant variable is used to describe temporary or constant variable of dynamics model. For example, the initial resource quantity of knowledge collaboration network is a constant variable, and the knowledge demand quantity accepted by knowledge supplier which is exceeded the velocity will be taken as an auxiliary variable.

(4) Flow edge

Flow is described using wire symbol with directional arrow, representing the causal relationship between the two terminals. Therefore, the knowledge the velocity of handling knowledge by knowledge supplier or the velocity of handling knowledge by knowledge demander are both described as flow edges.

(5) Information edge

Information edge is represented as a connector edge of the type used in the causal loop diagram. Besides flow edge, Each relationship between any two variables will be described as a information edge.

The five symbols are exhibited below in Fig. 4. To accomplish the transition from conceptual model to simulation model, every variable and edge in the causal loop diagram must be identified as to types.

C. Simulation Model

As above, a conceptual model of system dynamics can be described as a cause effect diagram. For simplify, this paper will not give the cause effect diagram of the catastrophe model, and directly given the flow diagram.

In a real environment, knowledge collaboration network may come forth a catastrophe phenomenon because of many factors distributed globally in the network, which is same as a catastrophe phenomenon in a busy telephone system under a huge emergency event. However, most of the time, a catastrophe phenomenon maybe be inspired mainly by some local reasons such as a few unusable relationships, even only one unusable relationship. Therefore, in this paper, we will only research the latter catastrophe phenomenon of knowledge collaboration network.

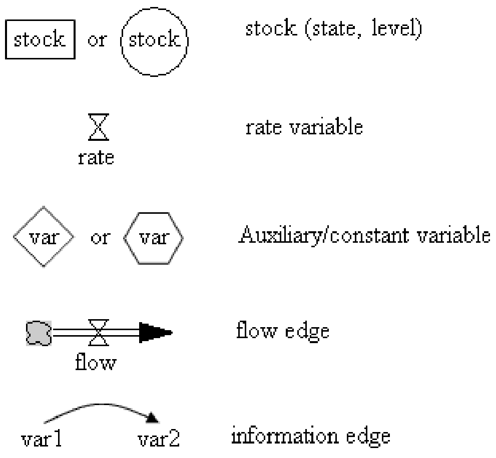

Figure 4. Symbols of flow diagram

Based on the catastrophe model of knowledge collaboration complexity network, simulation is developed with VERSIM dynamics simulation software environment. Dynamics model and simulation results are presented as following.

The dynamics model of catastrophe phenomenon in knowledge collaboration complexity network is as Fig. 5.

Where, symbols are defined as followings:

N -- The quantity of handling knowledge demand,

P -- The velocity of handling knowledge by knowledge supplier,

Q -- The velocity of handling knowledge by knowledge demander,

U -- The unhanded knowledge demand quantity $U_j(n)$ at the time t_n,

S -- The resource quantity used at the time t_n,

S0 -- The available quantity of resources,

E -- The collaboration cost, i.e., the unit quantity of knowledge resources needed in knowledge collaboration,

d -- The parameter $\delta = P - Q$ ($\delta > 0$),

e0 -- The knowledge demand quantity at the start time t_0,

eee -- The knowledge demand quantity (ε) accepted by knowledge supplier which is exceeded the velocity P,

eE -- The parameter εE,

R, T, TN -- Temporary parameters.

The causes tree of the catastrophe dynamics model is shown as Fig. 6, which gives the causes relationships between variables. For example, the variable N has three relationships with three variables U, P and S0, the variable U has three relationships with three variables T, e0 and R, and so on.

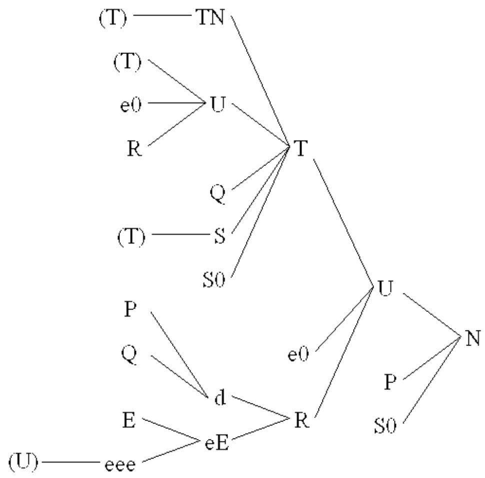

Figure 6. Causes tree of the catastrophe dynamics model

The uses tree of the catastrophe dynamics model is shown as Fig. 7, which gives the uses relationships between variables. For example, the variable T has been used by three variables TN, U and S, the variable U has been used by three variables T, eee and N, and so on.

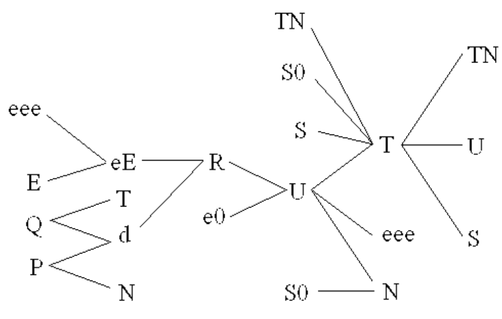

Figure 7. Uses tree of the catastrophe dynamics model

Codes of the catastrophe dynamics model are shown as Fig. 8.

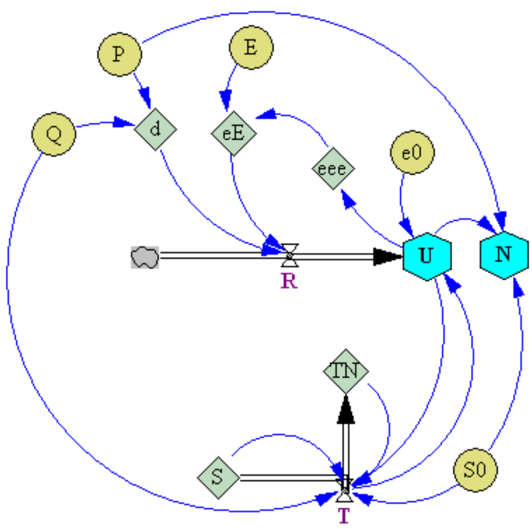

Figure 5. The dynamics model of catastrophe phenomenon in knowledge collaboration complexity network

D. Simulation Strategies

For simulating the catastrophe phenomenon in knowledge collaboration network, we will declare all initial conditions of simulation according to the above six hypothesize of the catastrophe conceptual model.

(1) Resources

```
(01)  d=P-Q
      Units: **undefined**
(02)  E=0
      Units: **undefined** [0,2,0.01]
(03)  e0=0
      Units: **undefined** [0,2,0.001]
(04)  eE=eee*E
      Units: **undefined**
(05)  eee=U
      Units: **undefined**
(06)  FINAL TIME  = 100
      Units: Hour
      The final time for the simulation.
(07)  INITIAL TIME  = 0
      Units: Hour
      The initial time for the simulation.
(08)  N=IF THEN ELSE( S0-U>0,  (S0-U)/P, 0)
      Units: **undefined** [0,1000,1]
(09)  P=1
      Units: **undefined** [0,2,0.1]
(10)  Q=1
      Units: **undefined** [0,2,0.1]
(11)  R=IF THEN ELSE( eE-d >0 , eE-d , 0 )
      Units: **undefined**
(12)  S=T
      Units: **undefined** [0,1000,10]
(13)  S0=1000
      Units: **undefined** [0,1000,1]
(14)  SAVEPER  =
     TIME STEP
      Units: Hour [0,?]
      The frequency with which output is stored.
(15)  T= INTEG (IF THEN ELSE( S<(S0-( Q*TN+U)), Q*TN+U,
      0),0)
      Units: **undefined**
(16)  TIME STEP  = 0.5
      Units: Hour [0,?]
      The time step for the simulation.
(17)  TN= INTEG (IF THEN ELSE( T>0, 1,0),0)
      Units: **undefined**
(18)  U= INTEG (IF THEN ELSE(T>0, R ,0 ),e0)
      Units: **undefined** [0,100,1]
```

Figure 8. Codes of the catastrophe dynamics model

Knowledge collaboration will happen when there are some resources in the knowledge collaboration network.

(2) Operational efficiency

Knowledge provider will provide knowledge with a certain rate, and knowledge demander will receive that knowledge with another rate. However, their rates may be same. At that time, the resources will be consumed by the both knowledge collaborators with a same rate.

(3) Initialization

In reality, a knowledge collaboration network will be affected by multifarious factors; therefore, we have to limit the initializing status by setting initial value of some parameters at first.

Here, we define $P=1, Q=1, S0=1000$, then, if no catastrophe phenomenon happens, resources will exhausted by knowledge collaborators when the handing knowledge number exceed 1000 units at any time. Moreover, we define $E=0$ and $e0=0$.

In order to simulate various kinds of catastrophe phenomenon as much as possible, the following simulation strategies will be adopted in the simulation procedure.

In the above simulation model, there are five parameters $(Q, P, E, e0, S0)$ could be adjusted when the simulation is in a dynamical status. Their adjustment range is shown in Fig. 8. And, Fig 9 shows the dynamical simulation adjustment status of the catastrophe dynamics model in simulation environment.

We propose three simulation strategies as following.

(1) Zero cost strategy

The collaboration cost is the unit quantity of knowledge resources needed in knowledge collaboration. So, let $E=0$, and $P>0, Q>0$. Then, $e0=0$ or $e0>0$ should be treated as two different cases.

(2) Short knowledge supply strategy

When $P>Q>0$, the knowledge collaboration network will be short of knowledge supply. Obviously, all knowledge handing demand will be processed in time. However, resources will be exhausted along with the demand number increasing, and catastrophe phenomenon may appear at some time.

In this case, $E>0, e0\geq 0$.

(3) Short knowledge demand strategy

When $Q>P>0$, the knowledge collaboration network will be short of knowledge demand (i.e. supply over demand). Obviously, at sometime, some knowledge handing demand will not be processed in time. Then, the unhanded knowledge demand quantity will increasing, and catastrophe phenomenon may appear. At last, resources will be exhausted, and catastrophe phenomenon may appear at some time.

In this case, $E>0$, $e0\geq 0$.

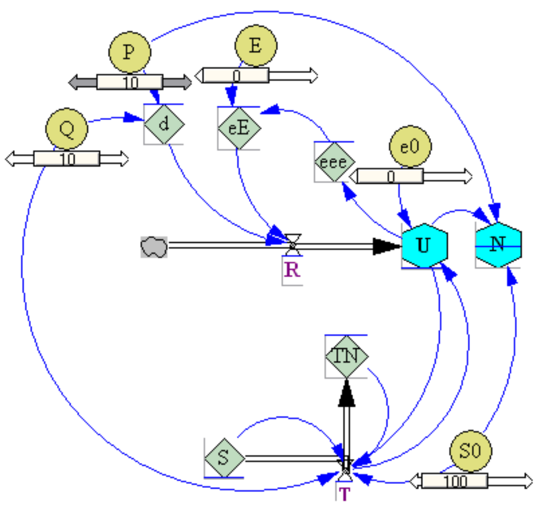

Figure 9. Dynamical simulation status of the catastrophe dynamics model

V. Simulation Results

We simulate the catastrophe dynamics model with three above strategies, so as to analysis the system dynamics behaviors.

(1) Zero cost strategies

In this case, $E=0$, and $P>0$, $Q>0$. So, set $Q=1, P=1\sim5$.

a) If $e0=0$

When $P\geq Q$, N value will change by various P value, but will not change by Q value. Simulation result is as Fig. 10.

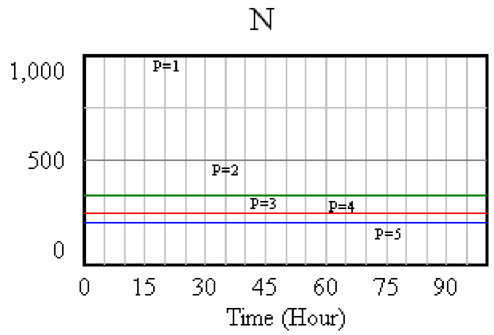

Figure 10. Simulation result (E≥0 , e0=0, Q=1)

But, when $P<Q$, if P is fixed as 1, N value will not change by various Q value.

b) If $e0>0$

If set $e0=1$, when $P\geq Q$, simulation result is same as Fig. 10.

But, when $P<Q$, N will decreased linearly along with time, simulation result is as Fig. 11.

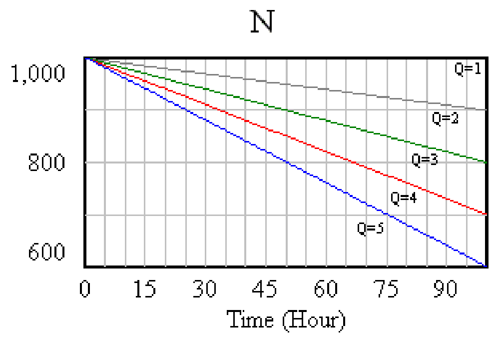

Figure 11. Simulation result (E≥0 , e0=1, P=1)

(2) Short knowledge supply strategies

In this case, E>0, $e0\geq0$, and P>Q>0. So, set E=1, Q=1, P=1~2.

a) If e0=0, Simulation result is similar as Fig. 10.

b) If e0>0, set e0=1, When formula (9) holds, i.e., eee*E-eee>d, catastrophe phenomenon will appear, as shown in Fig. 12.

(3) Short knowledge demand strategies

In this case, E>0, e0>=0, and Q>P >0. So, set E=1, P=1, Q=1~5.

a) if e0=0

When $Q\geq P$, N value will change by various P value, but will not change by Q value.

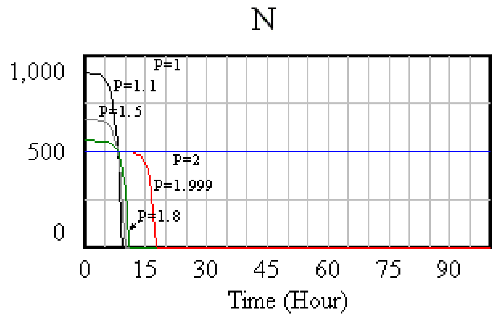

Figure 12. Simulation result (E=1, e0=1, Q=1)

b) if e0>0

Catastrophe phenomenon will appear, as shown in Fig. 13.

Fig. 13 has shown the quantity of handling knowledge demand decreasing rapidly in knowledge collaboration complexity network when the velocity of handling knowledge by know-ledge demander varies from 1 to 5. As shown in Fig. 13, the quantity of handling knowledge demand will decreasing at a definite time, that is, the catastrophe phenomenon occurred in knowledge collaboration complexity network.

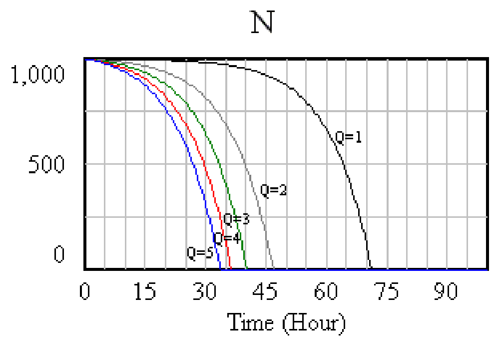

Figure 13. Simulation result (E=0.1, e0=1, P=1)

So, we can obtain all cases of knowledge network dynamics, as shown in Tab. 1.

Table 1. Cases of catastrophe phenomenon in knowledge network

		Catastrophe	
		e0=0	e0>0
E=0	P>Q	NO	NO
	P<Q	NO	NO
E>0	P>Q	NO	YES
	P<Q	NO	YES

VI. Conclusions

In this paper, the catastrophe phenomenon in the knowledge collaboration complexity network is studied. The reasons of catastrophe are given, and a catastrophe model of knowledge collaboration complexity network is proposed. Then, Using with the dynamics simulation tool VERSIM, a dynamics model of catastrophe phenomenon in the knowledge collaboration complexity network is built. Moreover, the simulation results disposed some reasons of catastrophe phenomenon in the knowledge collaboration complexity network. However, the study is elementary, more complexity parameters will be included in the simulation model, and more profitable results will be expected.

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