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Analysizing the Realization Mechanism of University Scientific Research Team Knowledge Sharing Based on Small World Network Model

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Abstract: Small world network theory is a new development of complexity science in recent years , this theory can also be used to analyze innovation activities of the university scientific research team . This paper, using the small world network model,   analysize of scientific research team in university network relations and the characteristics of network structure, and analysize the W-S small world network model applicability of university research team. By using the characteristic path length and agglomeration coefficient of small world network, the two most basic structure characteristic analysis of university scientific research team innovation network knowledge sharing mechanism, on the basis of this, to put forward to cultivate the path in the network of knowledge sharing in the university scientific research team, in order to accelerate the construction of university scientific research team provides new ideas.

Keywords: Small world network, the university scientific research team, knowledge sharing, team network

1.   INTRODUCTION

In nineteenth Century and twentieth Century, the science is based on single subject analysis as the main method , and interdisciplinary integration is the key point to the development of science and technology in twenty-first Century. Human beings are in era of change from solving a single problem of spaced from each   other   to   solving   the   "problems"   of   cross   disciplinary, cross   domain and cross level , inter disciplinary show features of both highly differentiated and highly integrated. In today's world, the most of a major breakthrough in the frontiers of science and producing great originality scientific research achievements is the results of interdisciplinary integration. In scientific research, this era requests urgently to be more close of cooperation between people and people, organization and organization, to play"synergistic effect".

In 2004, with the Ministry of Education introduced，"the Yangtze River scholars and innovation team development plan" , at the national and provincial key university has born many university scientific research team , the team play an important role to optimize allocation of scientific resources and enhance the ability of innovation of science and technology . In 1998, Watts and Strogatz based on the regular networks and random networks research put forward on the small world network theory [1], the small world network (SWN) model can reflect the real characteristics of social network, as a quantitative description and analysis of realistic social network tool, In the "knowledge collaborative innovation" era, which the basic is science and technology into the "interdisciplinary integration" , the research of the university scientific research team ,   the University "in-novation" of cells , can make use of the theory of small world network to realize. Therefore, this paper attempts to use "small world" theory, appeared in this research field in network theory, to analysis of university scientific research team knowledge sharing activities, thus it puts forward to the cultivation of university scientific research team knowledge sharing network path, provides a new perspective for accelerating the construction of university scientific research team.

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2. ANALYSIZING THE RATIONALITY OF UNIVERSITY SCIENTIFIC RESEARCH TEAM KNOWLEDGE SHARING BASED ON SMALL WORLD NETWORK THEORY

2.1 The essence of university research team: network organization

University scientific research team in the narrow sense refers to the cooperation between the University and the university internal team. Universities base on the restrictive factors in favor of innovation achievements ,such as the reasonable academic structure, age structure, specialty characteristics and so on , with excellent academic leaders as the captain, with   scientific research innovation as purpose , with research and development of science and technology as the content, around the national major application basic research and the advanced research, major projects and key disciplines, professional and course, by complementary skills and willing to take the mutual responsibility to common goals , and some expertise in various fields are composed of basic academic organization. Broadly speaking , It refers to the form of team cooperation,between Between colleges and enterprises, among universities , research institutes and various actors   within the national innovation system including universities[2]. University scientific research team's basic features is   knowledge communication, academic innovation and knowledge complementarity , it is essentially the organization of multiple interrelated and interaction of organizations to participate in networking and social , innovation network will undoubtedly affect the performance of university scientific research team.

In the background of cross disciplinary interaction, scientific research need to interact with the subject of the research on different background , it is difficult to only rely on their own knowledge and technology   to adapt the rapid changes in market demand and technology. In the university scientific research team, members of the team, such as team leader, teacher, student and so on, as subject of network, interacted directly or indirectly with others, the direct or indirect link constitute the network relationship, and these connections is knowledge sharing activities. indirect link triggered a view about dynamic management information network and as a knowledge transfer efficiency[3] . University scientific research team construct "knowledge network" in the university and among the university , "knowledge network" Interacts among nodes, cross and complementation disciplinary knowledge. At the same time, embedding provides an opportunity to form a complementary knowledge and innovation network for university research team obtained. The global structure of social networks are not random, but   stylized, like distributed link, high agglomeration coefficient and short path between any node [4]. University scientific research team also has the network relationship , when the team members are in a scale-free network, it is more conducive to knowledge sharing than in a regular network. University scientific research team based on the promotion of social capital, one of the most important goal is the acquisition of knowledge, university scientific research team   will try to pursue the filling structure hole in its network, it needs to be realized through knowledge sharing.

2.2 Analysizing the applicability of university research team based on the W-S small world network model

Small world network structure model is widely concerned, method of small world network structure , Watts and Strogatz proposed, can break through irrational limitations of the original rule network   ,   detect randomly new organization pattern. As a branch of the theory of social network, small world network has higher resource flow   and wider resources integration range than the regular network .The diffusion mechanism of the small world network in the random enough high and to the percolation threshold case is the same as the propagation mechanism of random network（Newman，Watts(1999)；d Moore，Newman(2000)）[5][6]. Rules of constructing the model is: (1) Began in the rules of network: From the beginning of the regular network with N nodes, and each node is associated with its initial 2K neighbours (In each side has K edges) , and satisfy $N \geq k \geq \ln(N) \geq 1$, to ensure that the network is sparse. (2) Randomization: For each edge, there is the probability of P to change the objective connection point and reconnection (the breaking bond reconnection), at the same time to ensure that no self connections and repeated connection , it will generate the PNk/2 long distance edge to

linked a node and a distant node , these edges are called shortcut. Therefore, research by changing the p value achieve to exchange from rule network (p=0) to the immediate network (p=1). The model in the above rules has the characteristics of random network small word, Demonstration result shows, the two points are the common attributes of most real networks[7][8]. Compared with the regular networks and random networks, small world network model can better suit the realistic network characteristics.

Cowan and Jonard regard knowledge diffusion as barter transaction process among the network members (Barter Exchange), research on the relationship between knowledge diffusion and network structure, the simulation results show: Knowledge diffusion has obvious characteristics of small world network, when the network structure shows a small world network characteristics, the average knowledge level of network node in the highest , between nodes with a larger gap[9]. In the university scientific research team   small world network is a complex network relationship composed of team members through knowledge sharing, cooperative innovation activities, while the small world networks have optimized allocation of scientific resources ability, plays an important role in the enhancement of the university scientific research team and university technological innovation ability. The foundation of university research team building is knowledge complementarity, mutual benefit and win-win, according to the Pareto optimization theory, its formation is conducive to the promotion of each member of the economic income (research funding, scientific and technological incentives), and social benefits(scientific and technological achievements and scientific research ability promotion etc.), that is, the change of structure is beneficial to the improvement of the overall functions of the network, so the network structure of university scientific research team has certain regularity and randomicity, unable to use the standard rule networks or random networks to explain, while the small world network model of stochastic global and local existence rules can reflect the features of university scientific research team structure appropriately.

P=0 ————————————————————————————————▶ P=1
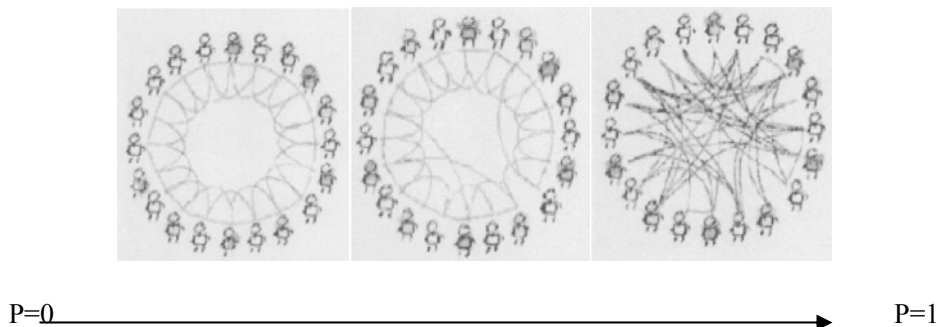
Figure 1. Comparison of three network structure

regular network, small world network and the random network

3.   ANALYSIZINH UNIVERSITY SCIENTIFIC RESEARCH TEAM KNOWLEDGE SHARING BASED ON W-S SMALL WORLD NETWORK MODEL

In the diffusion and knowledge sharing activities, small world network has a high performance (e.g. Cowan and Jonard，2004) [10]. According to the small world theory, in its network structure, L (Characteristic path length) refers to the average of the most   short distance between any two nodes in a network, the length and diameter of the characteristic path to measure the transmission performance and efficiency of network, global features representing network structure. C (Agglomeration Coefficient) is used to measure the partial characteristics of the network, reflect each point connection overlap, that is, representing parameters closely related degree of nearest neighbor nodes. From two aspects of characteristic path length and agglomeration coefficient ,it can be analyzed in the knowledge sharing of university scientific research team .

3.1 The characteristic path length and frequency of communication

In the small world network, the distance between nodes (Distance) refers to the minimum number of edge from one node to another node , wherein the maximum distance of all nodes to it called network diameter (Diameter). The shortest path(d_{ij}) between nodes(i,j), the calculation formula of characteristic path length (1) is as follows:

$$APL = \frac{1}{N(N-1)}\sum_{i \neq j} d_{ij}$$ (1)

Analysis on formula: *APL* type is the characteristic path length, *N* is the numbers of network nodes, i.e. the number of members within a network, d_{ij} is the shortest path between *i* and *j* node. The shorter the *L*, the higher network of relationships, knowledge and resource availability is. In the university scientific research team knowledge sharing activities, d_{ij} said the shortest distance between any two members(*i* and *j*) of the university scientific research team in the small world network . To be clear, d_{ij} is not the only representation of space physical distance between team members, also said between members of the social distance, such as all kinds of social relations, similar degree etc.. At the same time, the shortest distance between communication frequency and inter node is an inverse relationship[11]. That is, communication frequency ε_{ij} and the shortest path length d_{ij} is an inverse relationship. As shown in the formula (2):

$$\varepsilon_{ij} = k/d_{ij} \quad （k 为常数）$$ （2）

In the university scientific research team, members due to some differences on the knowledge sharing degree of identification, knowledge base and subject, the difficulty degree of knowledge sharing is different, it can give different values of the connecting edge, As shown in the formula (3):

$$APL = \frac{1}{N(N-1)}\sum_{i \neq j \in G} \frac{k}{\Im_{ij}} \quad （k 为常数）$$ （3）

Based on the formula, *K* indicates the difficulty degree of communication and sharing between the two members of the team or the team. Difficulty of knowledge transfer in the university scientific research team is inversely proportional to characteristic path length. Because knowledge sharing is a two-way process, in the university scientific research team, the marginal cost of knowledge sharing will increase with the distance, frequent communication close is conducive to knowledge transfer smoothly.

3.2 The agglomeration coefficient and agglomeration degree of knowledge transfer

In the small world network, the agglomeration coefficient of the nodes "*i*" describes the link between nodes of directly connected with the node in the network. The agglomeration coefficient "*C*" of network is arithmetic average of all nodes of the agglomeration coefficient. And N is the network rank. *C* represents the tightness between a node and other nodes, the more tightness,the higher agglomeration coefficient is. Not only in the social network, also in other types of networks, agglomeration phenomenon exist. Distance coefficient is between 0-1. 0 represents no agglomeration, l represents complete agglomeration, As shown in the formula (4):

$$C = \frac{1}{N}\sum_{i=1}^{N} c_i$$ （4）

For the convenience of calculation, an equivalent calculation formula of Ci is as follows(5):

$$c_i = \frac{2E_i}{k_i(k_i-1)}$$ （5）

Explanation to the equivalent is, Considering network node "*i*", it is connected through the k_i edges and other k_i network nodes (neighbors) . If the k_i neighbors is part of a group , there is $k_i(k_i-1)/2$ edges between them. Among *n* neighbors actually the ratio of the number of edges "E_i" to the total number of edges "$k_i(k_i-1)/2$" is local agglomeration coefficients of node "*i*", "C_i"[12].

Knowledge sharing of university scientific research team is a network organization ,which center node is the team leader, strong connection makes concentration degree of knowledge sharing network increasing. When a node becomes a center node in the network, it increases the connection of other non-central node. Denominator of C_i is constant, numerator increases, which also led to the increase of the agglomeration coefficient .The concentration degree of university scientific research team knowledge sharing network and small world group coefficient synchronous growth, which also make group coefficient to simulate the control communication concentration possible .High concentration degree will effectively promote the sharing and communication of knowledge, can control the degree of agglomeration among team or team members through the agglomeration coefficient adjustment, so as to optimize the network function.

4. REALIZATION MECHANISM OF NETWORK OF KNOWLEDGE SHARING IN UNIVERSITY SCIENTIFIC RESEARCH TEAM

4.1 Choosing the appropriate team leader and team members

The real purpose of university scientific research team is to create new theories and achievements in the field of scientific research, a good team should be a complementary team, selection of the appropriate team leader and team members is a prerequisite to achieve knowledge sharing of university scientific research team. The construction process of university scientific research team must emphasize the importance of team "leader". Team leader is the core of university scientific research team, and lead the team development direction. The research team by an excellent academic leaders can produce a synergistic effect of $1 + 1 > 2$. Team responsible person should be scholarly in the professional field of research, base on the frontiers of the discipline, with a strategic vision for the developing direction of the subject. At the same time, he must have strong management skills, be meritocratic, properly coordinate interpersonal relationships between team members, and be good with incentive mechanism. In addition, the character of team responsible person is particularly important, he must win people by virtue, and have profound artistic accomplishment, make the team into a unified with high cohesion.

The team members to play a supporting role in the scientific research team, request to match reasonable of age structure, academic structure, professional background, and professional title structure . In order to be able to lead the team to play a synergistic effect, so it should the team be "collaboration, shared vision, shared goals" , the member of the team be complementary of the knowledge structure ,be excelling at doing what you love , cooperate to finish the labor. In addition, difference of subject among team members can also develop ideas of the research, diversify perspectives and methods, make the overall level of the team improved.

4.2 Building good communication and information transfer mechanism

Establish good communication and information transfer mechanism is a key to achieve knowledge sharing of university scientific research team, through the communication of university scientific research team members to pass each other ideas and exchange of information, it can achieve mutual understanding. The establishment of communication and information transmission mechanism firstly requires good communication atmosphere, it requires academic and interpersonal communication among team members, to make team members to reach consensus, eliminate unnecessary emotions and academic conflict, with much understanding. Secondly, it need team members trust each other [13]. A model is put forward to exchanges trust between the two sides to development, the trust will be divided into three types: Contract-based trust, cognitive-based trust and identity-based trust, with the increase of frequency and strength of contact, trust between people will gradually from the calculation-based trust to knowledge-based trust, then to identity-based trust. Only mutual trust , among the team members, can reduce conflict in communication, accelerate information transmission. At the same time, it also need effective communication platform. One is a research and development center as a

platform to promote the transfer of information and technology transformation and innovation, to achieve a win-win benefit. Two is the key laboratory, center, base as the platform to integrate resources, an important innovation of technology, and application of major scientific research projects. The three is a major project as the platform for the combination of multiple subjects, strengthen the integrated innovation capacity team [14]. These can reduce the cost of information exchange, solve information asymmetry and time delay information problem, maintain a smooth flow of information transfer.

4.3 Formation of team interaction learning mechanism

The formation of team interaction learning mechanism is the foundation to realize the knowledge sharing of university scientific research team. University scientific research team is the learning type organizations, team members realize the crystallization of collective wisdom through mutual learning, constantly exchange based on trust, improve the innovative thinking ability based on the knowledge sharing. They are people-centric and establish equal "academic dialogue" platform. According to the Johor model of R - and F - Ludlow Panton , namely "Ohari window" [15]. People knowledge is limited; there is no absolute knowledge authority, not "command" and "administrative leading academic"[16]. When the individual team members study，the interaction must communicate with others, so that to think collide though different research expertise, ideas of team members between different knowledge systems, and get more ideas, learn from each other to more knowledge, learn from each other, broaden their horizons, to "a group must be many ideas, many ideas must be wisdom, being wisdom must be strong " effect, resulting in innovative ideas and research results.

4.4 Formation of a reasonable mechanism for the benefits distribution

The formulation of reasonable benefit allocation mechanism is guarantee of the realization of knowledge sharing of university research team, In the initial stage of development team building , material incentive effect is not obvious, but with the enhancement of the strength of the team, formulation reasonable benefit allocation mechanism is particularly important for constructing knowledge sharing network.. A reasonable mechanism for the benefits distribution should follow the fair, reasonable and open, profit balance principle, also need to have a certain incentives. Fair and reasonable of the distribution of interests is the basic standard of incentive. In the team, the team responsible person security team members are equal, the research results of each member can be treated equally, in order to maintain the stability of the team and long-term development, to maximize the overall interests of the team. The formulation of reasonable benefit allocation mechanism and giving full play to its role of safeguard make it become allocation mechanism which is in accordance with the laws of scientific research, fully mobilize the enthusiasm and promote a harmonious and orderly operation of scientific research team members. According to the investment return and equivalence rules, the more team members spend the effort and contribution to the entire group, the more the income should be distributed. The research team to the team member's contribution rate make scientific assessment in the distribution of benefits, on the basis of equity balanced efficiency, security reasonable benefit team members, maximize the mobilization of the enthusiasm and creativity of the team members.

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