RELATIONS OF THE ORGANIZATIONAL NETWORK CLUSTERING COEFFICIENT AND ACADEMIC STRENGTH OF THE UNIVERSITY

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Abstract.*This article aims to describe how employee organizational network clustering coefficient can affect the academic strength of university. We have simulated the influence of clustering coefficient using communication frequency. Our hypothesis was that the improvement of communication can increase the academy strength of university. Densely related clusters provide better and faster communication within network, which we simulated using communication probability between individual nodes, and probability of information transfer within that network.We have also shown how increase of number of connections between nodes can influence increasing the probability of information transfer within the teaching staff.Better connectedness and communication within the teaching staff members positively affects cooperation. Better cooperation can imply greater commitment, better research papers, and also better ways of transferring knowledge on students which will ultimately increase the academic strength of the university. Intense communication will also influence transfer of tacit – internal knowledge that will unconsciously affect on deepening the approach to the matter, and also on better research quality implemented by the teaching staff.The conclusion we have reached in this research is that the increase of clustering coefficient improves communication among teachers, and thus on increasing the academic strength and reputation of the university.*

Key words: *clustering coefficient, simulation, probability, network, academic strength, university.*

1. INTRODUCTION

This article discusses the influence of clustering coefficient on the academic strength of the University. When we discuss the academic strength of the University we think of reputation and quality of knowledge that is transferred to university students. In this article we will try to determine the manner in which a high degree of clustering enables the increase of academic strengths of universities. The effect of clustering coefficient on the academic strength of the university will be observed through the channels of communication among teachers. We believe that the improvement of communication channels will affect on making of cohesion of different skills that will help in transferring knowledge to the students, and consequently the reputation of the university.

Even the first theorists who were dealing with networks realized that the strength of the network lies in its connections (Pool and Kochen, 1978; Rapoport and Horvath, 1961). The nodes are connected with direct and indirect connections within a network. As a result of these connections, members embedded in these networks gain access to information and knowledge of direct partners and that of others in the network to which they are indirectly connected (Ahuja 2000; Guliati & Gargiulo 1999).

Connected nodes in the network create channels that direct the movement of information and knowledge across the network (Ahuja 2000; Owen – Smith & Powell 2004). Each member of network is acting both as a recipient and as a transmitter of information (Ahuja 2000). The structure of these networks greatly affects the dynamics of diffusion of information within the network.

Large-sample studies have found that direct alliance relationships facilitate knowledge flows between partners (Gomes-Casseres 2006, Mowery 1996), and enhance the innovative performance of firms (Deeds & Hill 1996; Stuart 2000). This research is also applicable on Universities where the actors aren't firms but teaching staff. We believe that a better networking, with better relationships and increased communication among teachers also allow movement of knowledge within the university. This movement of knowledge and information can increase innovation and creativity of university staff, and therefore the academic strength of the university.

In a related study Uzzi and Spiro (2005) examined the network structure of the creative artists who made Broadway musicals from 1945 to 1989, and concluded that the large-scale structure of the artists' collaboration network significantly influenced their creativity, and hence on the quality of musicals that they have worked on. This research has caused us to question whether the interconnection of the teaching staff may affect the increase in the quality of teaching, which would later imply and increase the reputation of the university.

We have used clustering coefficient as basic tool for illustrating this hypothesis. Sociologists (Coleman 1988, Granovetter 1992) have suggested that densely clustered networks give rise to trust, reciprocity norms, and a shared identity.However, the essence of Granovetter's work is focused on the "strength of weak ties" (Granovetter 1973; Granovetter 1983). High clustering coefficient, increasing interaction, affection and giving history to the relations between employees, a relation Krackhardt (1992) relates as "Phylos". All these elements lead to a high degree of cooperation that affects innovation and creativity in their work. Greater transparency, trust and reciprocity that emerges within clusters (Uzzi 1997), are not the only benefits that provides a high degree of correlation within clusters. The intensive interaction among cluster members leads to the exchange of tacit - internal knowledge (Hansen 1999, Zander and Kogut 1995). The high degree of clustering coefficient (high degree of correlation), indicates an increase in the capacity of transmitting information through the possibility of disseminating information rapidly to all nodes in the network. Such a network structure corresponds to densely connected social capital, which is seen as one of the organizational advantages (Nahapiet & Ghoshal 1998).

2. METHODS

Method that is used for the analysis is simulation of clustering coefficient increase in organizational network. Method is combined with experience from case study analysis and inductive reasoning. Clustering coefficient represent relation of the number of formed triangles (three

nodes connected to each other), and the number of triangles that can be formed in a network. To explain how the greater degree of clustering coefficient influences communication increase, we have simply used the probability of transmission of information. Consider the following picture:

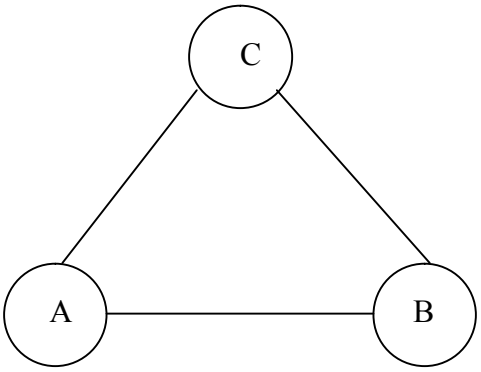

Figure 1. Clustered triangle

We can see three connected nodes in the picture. Every node is in interaction with the other two nodes. We will consider relations between them as a two-way communication channels (node A can transfer information to node B, and node B can also transfer information to node A). We can now take set the probability of information transferring from one node to another at 0.5. By this probability we consider that there is 50% chance of transferring information from one node to another.

3. RESULTS

A detailed analysis of influence of clustering coefficient was conducted on 5 node network. We began with the assumption that every node in the network is connected with two neighbor nodes (A-B; B-C; C-D; D-E; E-A). This way we acquired connected network where clustering coefficient equals 0. The picture will show us basic network model on which we started our research:

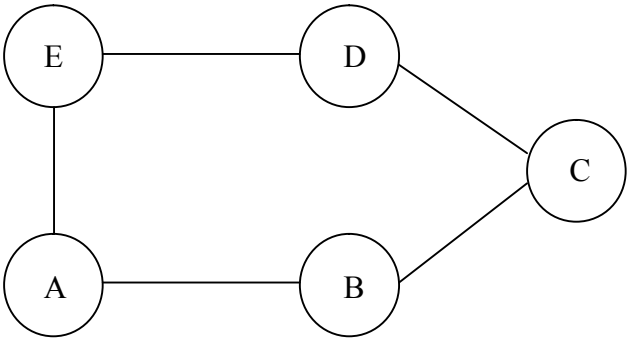

Figure 2. Non-clustered organizational network

Once we have set up a basic model, we started with the simulation by adding of new connections. In each new iteration, we added one new connection, and increased clustering coefficient by increasing the number of triangles. Each link in our network represents a two-way connection between nodes that are linked together. It should denote the information transfer probability from one node to another. The value of the probability of transmission of information in our analysis is 0.2 (which means that the node A will transfer information to node B with the probability of 0.2).

In this model we observed transmission of information from node A to node D. In our basic model only two ways of information transfer from node A to node B was across node E (AED) and across nodes B and C (ABCD). By adding new connections various possibilities of information transferring emerged and indicated new ways of getting from node A to node D. When calculating the different ways of connecting node A and node D, we did not take into our account links that will include same node more than once. We only used the connections in which every node is used once. In the following table we will show the influence of clustering coefficient to increase the probability of information transfer from node A to node D.

Influence of clustering coefficient on increasing the probability of information transfer			
Iteration	Added connections	Clustering coefficient	Probability
1		0	0.048
2	+EB	0.1	0.0576
3	+DB	0.3	0.1056
4	+AC	0.4	0.1552
5	+EC	0.7	0.1776
6	+AD	1	0.3776

Table 1. Simulation results

As we can notice, each iteration increases probability of transmitting information. In the first iteration (our basic model) there were only two ways in which information could be transferred from node A to node D. Those two ways are AED and ABCD. The probability of transmitting information via links AED we managed to get by multiplying the probability of information transfer from node A to node E (AE) with the probability of information transfer from node E to node D (ED):

Paed = Pae*Ped = 0,2*0,2 = 0,04

Paed – Probability of information transfer from node A to node D across node E

Pae – Probability of information transfer from node A to node E

Ped – Probability of information transfer from node E to node D

In a similar manner we calculated the probability of information transfer from node A to node D across nodes B and C:

Pabcd = Pab*Pbc*Pcd = 0,2*0,2*0,2 = 0,008

We sum up the probabilities and got the probability of information transfer from node A to node D:

Pad1 = Paed+Pabcd = 0,04+0,008 = 0,048

In second iteration we added connection between nodes E and B (EB). By adding new connection we increased the probability of information transmission and provided four new ways for information dissemination. With this 4 ways of information transfer probability has increased, and now it amounts 0.0576. We apply the same principle for other iterations. The result we obtained was expected, and that is that with each new iteration, the probability of transmission of information grew. When we reached the maximum clustering coefficient, the probability was almost twice as high as in the structure where nodes A and D are directly connected. This illustrates the fact that the network is, in the spirit of Aristotle systematic review, more than the sum of its parts.

4. DISCUSION

In analyzing the influence of clustering coefficient on magnifying the academic strength of universities we observed an idealized model of connection among the teaching staff. We did not take into consideration influence of different attributes such as formal procedures for communication that are prescribed by the university. We also did not consider the behavioral aspect of teaching staff nor the appearance of any disagreement among the teachers. Our relations were binary, without details describing the relation. We tried to establish how would clustering coefficient function in the idealized system and how would he support the transfer of knowledge, ideas and skills among the teaching staff.

As a basic hypothesis, we pointed out that better communication among teaching staff will positively affect academic strength of university. We based this hypothesis on the idea that enhancement of communication will enforce the higher flow of knowledge, ideas and skills. This flow will enable teachers to observe matter they are dealing with, from different angles. We observed two ways in which communication could affect the magnification of the university's reputation:

1. Better communication can bring some innovation in their thinking, which can later be present in the scientific papers that will be published. Publishing quality scientific papers directly influence the enhancement of the academic strength of university.
2. Better communication will affect the transfer of knowledge in terms of curriculum and ways of transferring knowledge to students. In this way the matter would be more understandable and better explained to the students. The knowledge gained in this way is generally applicable in practice, and hence the students' employability will be greater. Increased employment of students from a certain university acknowledges the quality of the university, which positively affect on its reputation.

In this article we have simulated the direct influence of clustering coefficient on increasing the probability of information transmission.Greater speed and probability of transmission of information should imply larger aggregation of knowledge at the university. The effect of increased communication influences not only the sharing of information, yet the creating of synergistic effect where new knowledge will emerge from the existing knowledge.

Our analysis suggests that each new connection will not lead to the same increase in the probability of information transfer. Each new connection opens new possibilities for transferring information, and each link will contribute to facilitate interaction between the nearest nodes. The probability depends also on the manner in which the nodes will be connected. If the connection is formed away from the nodes between which we want to establish communication, the connection will not significantly affect the probability of transmission of information. On the other hand, if the new connection is created close to or between two nodes that we consider, the probability of transmitting information will increase dramatically. On the next two graphs we can see how the position of connection can affect the probability of information transfer.

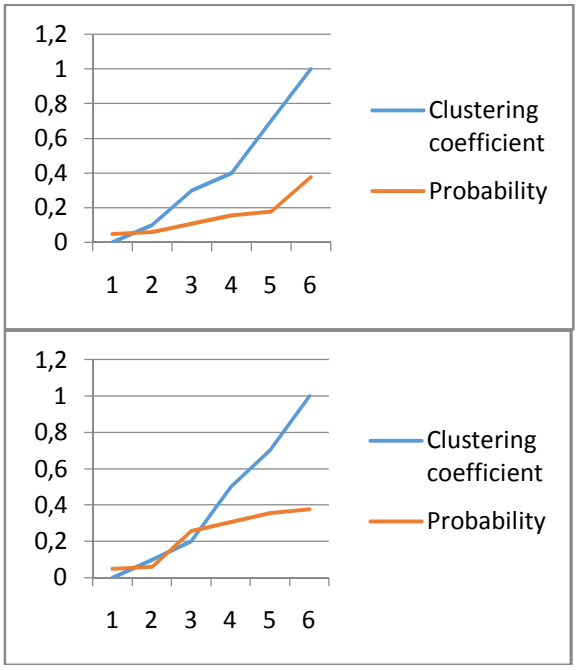

Figure 3. Simulation of clustering coefficient increase on different network structure development

As we can see from our graphs increasing of clustering coefficient always influence on increasing of probability of transferring information, but this relation isn't always proportional. Both graphs are showing us the same network model, the only difference is in order of adding new connections. On the first graphics direct link between nodes A and E was added last – in the sixth iteration, while in the second graph this relation was added in the third iteration. From these graphics we can clearly see that the probability will not grow for the same value with each new connection in the network.

This conclusion points us to another essential element that allows the degree of clustering affects the improvement of communication, and therefore the academic strength of the university. That element is network connectivity. There is a possibility that the network of teachers in the university has a high degree of clustering, but the network is not properly connected. Grouped, dense clusters (e.g. departments, collaborating cliques) often form in the network, and do not mutually share information and knowledge. On the organizational structure level, this phenomenon is known as "functional silo". (Ensor 1988). The disconnect network will affect the transfer of information in a way that information transfer will have a contribution only within the cluster, and will not reach its spread to the entire organization. The disconnected network is very present in the universities from both business and personal reasons. Many teachers believe that their subject has nothing in common with other subjects, and considered that they do not need to share knowledge with teaching staff from other departments. The existence of functional silos is observed and criticized in MBA curricula of top-ranked U.S. business schools (Navarro 2008). These teachers communicate only with teaching staff from their department, and departments dealing with similar matter. This reduces the possibilities of interdisciplinary, multidisciplinary and trans-disciplinary. Transfer of knowledge and ideas is not necessarily linked to scientific research - information or knowledge can be in the domain of good practices, or operational functioning of the organization. Information, knowledge and mostly ideas from other contexts

can encourage lateral thinking (De Bono 2010). It is considered an essential element of creativity, the inevitable factor of academic progress.

If we want clustering coefficient to have an influence on academic strength of university we must eliminate clusters and form functional integrated network. In practice this means eliminating organizational silos. We don't need to connect network to its limits, when clustering coefficient equals 1, which is in most cases practically impossible.It is enough to eliminate the "islands" in the network and focus on eliminating bottlenecks of communication that have a monopoly on bridging network capital. From our example we can conclude that relatively low clustering coefficient (0.4) enables information transfer with the probability 0.1552, in regard to the probability of0.2that we would get if we had direct connection between nodes. In practice, this would mean that the remote professors at the University will transmit information on similar scale as if they were in the same department. Every relation that is established between the clusters represents a great opportunity for the exchange of knowledge and information between clusters.

5. CONCLUSION

Based on the analysis of the clustering coefficient, we have concluded that it can greatly affect the academic strength of the universities, but also that its influence does not have to be realized if the network is not connected, and organizational silos are present. Disconnected networks dramatically drop chance to provide efficient information transfer within network. We have shown that with increasing clustering coefficient comes the growth of probability of information transfer among the participants in the network - in this case among the teaching staff. Probability increase can enforce grouping of knowledge and ideas, which will cause better cooperation among the teaching staff as well as easier and faster transfer of information. Improvement of information transfer will positively affect the communication and cooperation among teaching staff, which will implicate better ideas, researches and better plan and program of lectures. We have also shown that every new connection would not be equally important for increasing the probability of information transfer. The position of creating new relation will determine modification of probability, whether the probability will change dramatically or would it be an irrelevant change. Connections between dense clusters will be more influential on probability of information transmission than connections within clusters.

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