Open Society Progress
Providing and Confidentiality of Knowledge in the Small World

Ing. Jaroslav Šmíd,
Trenčín Regional Chamber of Slovak Chamber of Commerce and Industry,
Prof. Ing. Peter Sakál, CSc.,
Institute of Industrial Engineering, Management and Quality, Faculty of Materials Science and Technology, Slovak University of Technology

Abstract

The paper defines and explains the concept of the open innovation and the difference between open and closed approach of companies to the innovation. It also explains the model of the small world and its use in the simulation of knowledge diffusion as well. The generally used model of the small world is supplemented by the parameter of knowledge confidentiality. By using this model, it is confirmed that the society which freely shares knowledge has a higher aggregate level of knowledge than the society in which some members keep the knowledge confidential. The knowledge diffusion is also verified on the model of society in which knowledge is shared mutually by each member of the society.

Key words

Open Innovation. Cluster. Small World. Knowledge Diffusion

Introduction

The phenomenon of the small world can be simply explained by the fact that everyone knows each other thanks to people who are acquainted. Two mutually unknown persons living anywhere in the world have a connection through relatively small number of people. As shown in [1] the phenomenon of the small world appears in the real world in some cases, for example in networks arising in the nature and technology. Collaborating networks of innovative and research companies, knowledge exchange within the model of open innovation or the World Wide Web development and its similarity with the small world is also the subject of further studies. A survey of studies dealing with similarities of processes occurring in the real world and in the model of the small world is presented in many other papers [2] [3].

Open Innovation

According to Henry Chesbrough [4] open innovation is the purposive inflows and outflows of knowledge to accelerate internal innovation, and expand the markets. It means that companies can/should use both external and internal sources of knowledge and innovation, as well as internal and external paths to expand markets.

In the open innovation management model, the company uses the internal R&D as well as external sources, buys results and patents from other companies, cooperates with universities, R&D institutions. Moreover the results, which the company does not plan to use directly in the future, are offered for sale to other companies. The company gets additional financial resources and releases its own human resources. The company may establish a new

company which will develop the knowledge of the parent company further. The open model of innovation processes offers more options too, for example the free release of knowledge, organizing into clusters, associations and chambers.

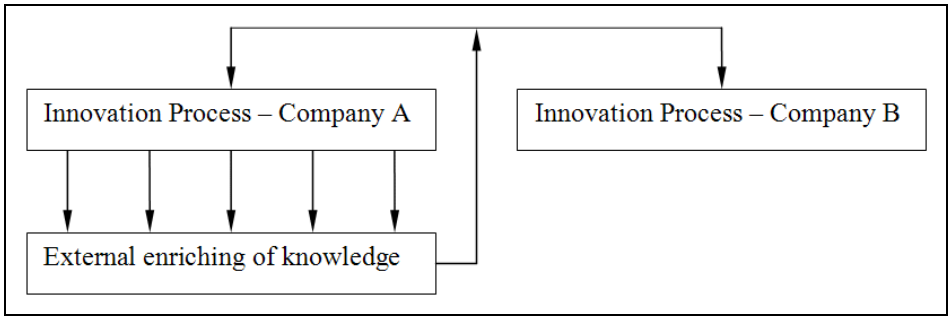

Figure 1 Supply / Confidentiality of knowledge
Source: Open Innovation – Rethinking [7]

Other principles and opportunities of the open innovation are introduced in [4] and [5]. A more detailed consideration of the company A in [6], which freely shares its knowledge with the company B, which on the other hand only takes and keeps knowledge confidential as shown in Fig.1.

Small World

In various papers, for example [3] and [7], the model of the small world is described and defined as a graph, in which every vertex/member has a direct connection with some other members and is endowed with certain knowledge. A random member that broadcasts its own knowledge to any other member is chosen in time. This happens via the direct connection and the same area of knowledge.

Let us consider the graph in Fig. 2, which consists of N members. Each member is connected to n nearest members. When modeling the situation, each member connection is changed with the probability p and is connected with the member which is chosen randomly without having any prior connection. Two extreme cases come to existence this way. The first, if the probability p = 0, in which no connection is changed (Regular world) and the other extreme, if the probability p = 1, in which all connections are randomly changed (Random world). If the probability is in the range of $0 < p < 1$, the so-called small world comes into existence, gaining interesting features.

The definition, the exact formal description and establishment of the small world model is given in [4]. Formally, let

$$V_i(t) = (V_{i,k}(t); k = 1, ..., K) \qquad (1)$$

be a vector of knowledge of the member i at time t for every category of knowledge k.

$$V_{j,k}(t+1) = V_{j,k}(t) + \max\{0, \alpha[V_{i,k}(t) - V_{j,k}(t)]\}; \; k = 1, ..., K \qquad (2)$$

is the vector of knowledge of the member j, after receiving the knowledge from the member i. Here, the parameter α reflects the increase of the aggregate knowledge of the member j by

receiving new knowledge, which together with the existing knowledge generates the new knowledge creation.

The average level of knowledge of the member i at time t is then:

$$\overline{\mu_i}(t) = \sum_k V_{i,k}(t)/K \tag{3}$$

The aggregate average level of knowledge of society is:

$$\overline{\mu}(t) = \frac{1}{N} \sum_{i \in I} \overline{\mu_i}(t) \tag{4}$$

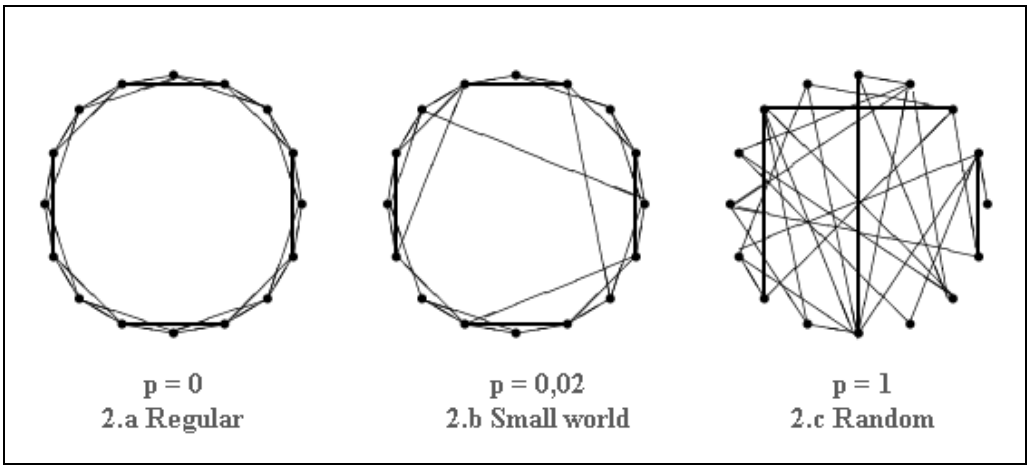

Figure 2 Transition of the regular world to the random one and the small world phenomenon
Source: The Dynamics of Collective Invention [3]

When creating the small world it is interesting to research two variables that characterize it: the average shortest path length λ and the average cliquishness C. The path length is the number of friendships in the shortest chain connecting two members. The cliquishness reflects how many friends (members, that have the direct connection) of one member are also friends of each other. The regular world is characterized by the high value of λ and C as shown in Fig. 2.a. In the random world the value of λ and C is low. The phenomenon of the small world arises when the value of λ is significantly reduced and the value of C remains high as the consequence of the influence of a few random connections.

Result

The impact of the knowledge confidentiality of some members to the aggregate average knowledge level of the cluster and its evolution was examined on the small world model. The knowledge confidentiality is characterized as the behavior of a member, who receives knowledge from other members, but does not share its knowledge. In our model this is represented by a situation, when some members receive knowledge according to (1), the knowledge is assessed according to (2) and when the time comes to broadcast their own knowledge, they broadcast it with the null value.

The computation and creation of the small world model was made with the following parameters:
The number of members N=100, the number of connections of each member n=16, the probability of change of each connection with another randomly selected member p=0,1 and the parameter α=1,2 that reflects the increase of aggregate knowledge of a member by receiving the new knowledge, that together with the existing knowledge generates new ideas. T=100 broadcastings for different number of randomly selected members that broadcast knowledge with the null value – non sender members were done in the following model of the small world. The number of non senders was divided into three categories: Non-Sender=0, Non-Sender=30 a Non-Sender=90. The average knowledge level of each member is computed according to (3) and (4) covering five different areas of knowledge Vi. These were randomly generated with the value from 0 to 100 in time t=0 (the initial level of knowledge). The aggregate average knowledge level as a function of time for different value of number of Non-Sender in our society is shown in Fig.3.

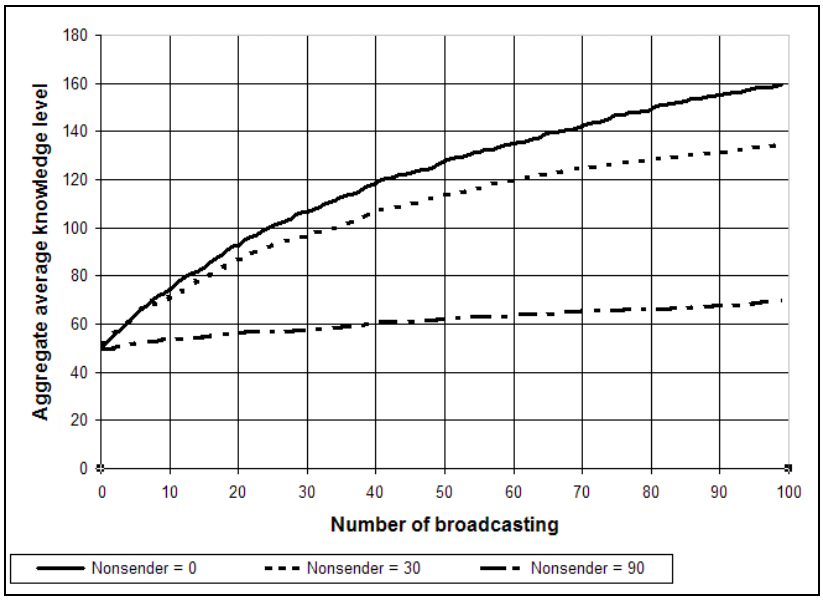

Figure 3. The aggregate average knowledge level as a function of time for different value of number of Non-Sender

The obtained results were verified and confirmed by the model under the same conditions with the exception that the knowledge is shared mutually. The small world model arises, when the number of connections of each member is close to the total number of members. The obtained results from this model are similar in nature. The difference is that the aggregate average level of knowledge with different values of number of members, who do not broadcast their knowledge in time, converges quicklier to the same value. However, the difference of the aggregated average level of knowledge in the early stages of the society development is significant.

Contribution

The contribution to the problematic is in the new parameter supplementing dealing with the knowledge diffusion in the small world. The number of members who

receive knowledge from other members, but on the other hand keep their knowledge confidential represents the new parameter. Monitoring the knowledge diffusion was supplemented with the extreme case – the average number of connections between members is close to the total number of members. This means that the knowledge is shared mutually. This model also confirms that the society which freely disseminates knowledge has a higher overall knowledge level and evolves rapidly in the early stages.

It should be stressed that the society, for example the cluster as an association of entrepreneurs, which shares knowledge, can form such society. It may be any society that consists of multiple clusters and individual members. One of the basic tasks of knowledge exchange in the cluster and outside the cluster is confirmed this way.

In the real world, various open discussion groups on the Internet, conferences, journals, proceedings, etc give everyone the possibility to present their findings to the entire society, clusters or cooperating groups. These are considered to be societies in which knowledge is mutually exchanged.

Conclusion

There is a number of additional parameters, which are neglected and which could be taken into consideration. Different thoughts on the knowledge diffusion were presented, for example, [1] [2] [3] comparing the phenomena occurring in the real world with the results obtained by the model of the small world.

Since this is a closed system, the knowledge converges to a certain level, which does not represent the real status. To keep the progress of the society, it is necessary to support the "progressive" knowledge. This entails the new paradigm – the change in the current way of thinking. This is represented by the irregular incidence of high α values in our model.

The knowledge diffusion research on models of the small world can continue by monitoring and comparing the level of knowledge of individual members that keep knowledge confidential and members that broadcast knowledge. Because of the fact that companies, institutions and independent researchers are not interested in releasing strategically significant knowledge and solutions before the end of the development, or represent an innovative higher order leap, the model can be enriched with the parameter reflecting the rate of knowledge release, or with the parameter, which attributes a certain strategic importance to the knowledge. The situation of desired and unwanted release of knowledge can be simulated in this model. The results can be further verified in real associations or groups by questionnaires surveys and personal interviews.

References

[1] D.WATTS, S.STROGATZ, Collective dynamic of the small-world networks
In: Nature 393, 440, (1998)

[2] JON KLEINBERG, The small-world Phenomenon: An Algorithmic Perspective
In: Cornell Computer Science Technical Report 99-1776, (1999)

[3] ROBIN COWAN, NICOLAS JONARD, The Dynamics of Collective Invention
MERIT, University of Maastricht, (2000)

[4] HENRY CHESBROUGH, WIM VANHAVERBEKE, JOEL WEST
Open Innovation: Researching a new Paradigm.
Oxford University Press, (2006), ISBN 0-19-929072-5

[5] JAROSLAV ŠMÍD, Otvorená inovácia [Open Innovation]
In: Procesný manažér. – ISSN 1336-8680. – Roč.3, č.2, s.11-14, (2008)

[6] JAROSLAV ŠMÍD, Otvorená inovácia – Prehodnotenie
[Open Innovation - Rethinking]
In: Obchod, priemysel, hospodárstvo. - ISSN 1336-8117. - Roč. XVIII, č. 04 (2009), s. 10

[7] ROBIN COWAN, Network models of Innovation and knowledge diffusion
MERIT, University of Maastricht, (2004)

Reviewers
Prof. Ing. Jozef Mihok, PhD., DMD GROUP, a.s. Trenčín
Doc. Ing. Pavol Božek, CSc., Faculty of Materials Science and Technology, Slovak University of Technology