Research on Science and Technology Information Dissemination Based on Homogeneous Networks

Wang Guanhui1*, Chen Yu1

School of International Business, Tianjin Foreign Studies University, Tianjin, 300204, China
*Corresponding author’s e-mail: newhop@126.com

Abstract. With the advancement of science and technology and the advent of the era of knowledge-based economy, knowledge sharing has become an important factor in the development of science and technology. This paper constructs a model of public sentiment information dissemination in the context of homogeneous networks, revealing the influence and control effect of the connection relationship between enterprise nodes in science and technology network on the dissemination of science and technology information. The alteration of critical thresholds helps to control the degree and speed of public opinion information dissemination by adjusting the parameters in the model.

1. Introduction
Scientific and technological innovation is the fundamental starting point for China to build a strong country in science and technology and achieve innovative development[1-4]. The most important management content of science and technology enterprises is enterprise knowledge management, which must manage the whole process of knowledge, including knowledge sharing[5,6]. Ensign believes that knowledge sharing, like commodity trading, is a process for knowledge providers to gain economic benefits in the knowledge market[7]. In the process of knowledge acquisition, use, sharing, integration and creation, knowledge sharing is the most difficult link to realize[8]. If science and technology enterprises want to win in the fierce market competition environment, they must acquire knowledge from the outside of enterprise, and knowledge sharing is related to whether science and technology enterprises can get effective knowledge to integrate and utilize. Current domestic researches on knowledge sharing among science and technology enterprise are both qualitative and quantitative, but study on the linkage of knowledge sharing and science and technology information dissemination is rare.

This paper constructs a propagation model of science and technology information, and puts forward the threshold theory of science and technology information transmission in science and technology information network, which can effectively control the degree and speed of science and technology information transmission, and promote the knowledge sharing of science and technology information enterprises.

2. Model Assumption
In the typical science and technology information network, there are different individuals with different views on the same thing. This paper divides these individuals into three categories:

It is the publisher of scientific and technological information that refers to the individuals who have not been influenced by scientific and technological information but may be influenced in the process
of scientific and technological information transmission. The number is denoted as \( S(t) \), which represents the number of individuals releasing scientific and technological information at time \( t \).

After the scientific and technological information is released by the disseminator, it is the disseminator of scientific and technological information that the individuals who have been affected and received the influence may also spread to the other individuals. The number is denoted as \( R(t) \), which represents the individual number of public opinion disseminators at time \( t \).

Those who are immune to scientific and technological information refer to those who are influenced by the public opinions issued by the disseminators of scientific and technological information and finally change their decisions, and will not be affected anymore. The number is denoted as \( A(t) \), indicating the number of individuals who are not affected and immune to this technological information at time \( t \).

On the basis of classification, the following assumptions are set:

(1) In this science and technology information network, the size of the network is fixed and the boundary is known. At time \( t \), no new nodes are added.

(2) It is the amount of scientific and technological information held by individuals, instead of those beyond the boundary that approaches decision making.

(3) Every individual decision-maker is rational. Thus:

\[
S(t) + R(t) + A(t) = M \tag{1}
\]

If we normalize both sides of this equation, we get

\[
\frac{S(t)}{M} + \frac{R(t)}{M} + \frac{A(t)}{M} = 1 \tag{2}
\]

With \( s(t) \), \( r(t) \) and \( a(t) \) respectively represent the proportion of scientific and technological information publisher, disseminator and immune, and they meet the following conditions

\[
s(t) + r(t) + a(t) = 1 \tag{3}
\]

Among them:

If science and technology information, which is delivered by the disseminator, is accepted by the immune, technology information immune is likely to change initial attitude. Assuming that change the proportion of the coefficient is \( \beta \), the individual number, which is affected by a scientific and technological information disseminator, is proportional to the \( s(t)r(t) \), the number of new affected individuals is \( \beta s(t)r(t) \) at time \( t \).

At time \( t \), the number of individuals who are not influenced by other disseminators of scientific and technological information is proportional to the number of actors, and the proportion coefficient is \( \gamma \), and the number of people who are immune to scientific and technological information at time \( t \) is \( \gamma r(t) \).

3. Model Building

In science and technology information network, there are many individuals. They connect and influence each other. We regard individuals as nodes in a technology information network. If individuals are connected or interact with each other, we connect the two nodes to an edge. If an individual is connected to many other individuals, then there will be many edges connected from this node, and we measure this by degree, which represents the number of edges connected. In this paper, homogeneous network was set up to classify models under different conditions.
3.1 Homogeneous Network

In a homogeneous network, individuals have similar status and the degree of importance, which is reflected in the network that the degree of each individual is approximately equal to the average degree. Based on the above assumption, the differential equation is constructed to get:

\[
\begin{align*}
\frac{ds(t)}{dt} &= -\beta k s(t)r(t) - \zeta s(t) \\
\frac{dr(t)}{dt} &= \beta k s(t)r(t) - \gamma r(t) \\
\frac{da(t)}{dt} &= \zeta s(t) + \gamma r(t)
\end{align*}
\] (4)

In the equation, $\zeta, \gamma, \beta$ are fixed transmission coefficients of scientific and technology information.

From the first equation in (4),

\[s(t) = e^{-\zeta t} e^{-\beta \int_{0}^{t} r(\tau) d\tau} \] (5)

When the system reaches steady state, let $\frac{dr(t)}{dt} = 0$, get

\[r(t) = \frac{\beta}{\gamma} k s(t)r(t) \] (6)

Put (5) into (6), get

\[r(t) = \frac{\beta}{\gamma} k r(t)e^{-\zeta t} e^{-\int_{0}^{t} \beta k r(\tau) d\tau} \] (7)

$r(t) = 0$ is a trivial solution to the equation, and for the equation to have a non-trivial solution, let

\[r(t) = f(r(t)) \]

we get

\[\frac{f(r(t))}{dr(t)} \bigg|_{r(t) = 0} > 1 \]

which is

\[\frac{\beta}{\gamma} k e^{-\zeta t} e^{-\int_{0}^{t} \beta k r(\tau) d\tau} \left[1 - r(t) \beta k r(t)\right] \bigg|_{r(t) = 0} > 1 \] (8)

We get

\[\frac{\beta}{\gamma} > \frac{e^{\zeta t}}{k} \] (9)
Because the "degree" of each individual in the network was not so far different, according to the six degrees of separation, the average degree $\bar{k}$ can be approximately 6, and $k$ can be regarded as the threshold to control the spread of scientific and technological information in the homogeneous network, in which the value $\zeta$ is generally considered to be a constant. When $\frac{\beta}{\gamma} \frac{e^{\gamma t}}{k}$, the scientific and technological information will eventually achieve homogeneous dissemination with the passage of time $t$. When $\frac{\beta}{\gamma} \frac{e^{\gamma t}}{k}$, the scientific and technological information will not realize the homogeneous spread of each node, but will only converge in the local and do not spread. At this time, clustering scientific and technological information may be produced, that is, it will only spread within the group within a certain range, with a small impact range.

In homogeneous network based model, status of individuals in the network are more similar, decision-making power is importance is more dispersed, in line with the science and technology in the early stages of formation and spread information, which means science and technology enterprises will hold their views for a technology, and science and technology information is in a variety of emotions, attitudes and opinions interweave each other, and the state of the game.

This model can be understood as the embodiment of the general rules of the dissemination of scientific and technological information. In order to control the size of the threshold, this paper assumes that the decision can only be made once. If it is allowed, each node will make repeated games, and chaos may appear, which is not conducive to the control of scientific and technological information.

4. Conclusion
The formation, change and dissemination of scientific and technological information are not only based on the scientific and technological information mastered by enterprises, but also influenced by its environmental factors. Therefore, the dissemination of scientific and technological information is the result of the interaction between scientific and technological information of enterprise and industry. Every enterprise can also be regarded as a node in the network of scientific and technological information, which forms a certain relationship between nodes and restricts the dissemination of scientific and technological information.

This paper combines the research of opinion dynamics and the characteristics of scientific and technological information, building a scientific and technological information dissemination model, covering homogeneous network, heterogeneous network and heterogeneous condition network. The critical threshold value under each condition is obtained to adjust the range of scientific and technological information dissemination. The first two models describe the general rules of the dissemination of scientific and technological information, while the third model provides a new perspective for us to control the dissemination of scientific and technological information.

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