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Method for Extracting Technology Transfer Broker Based on Social Network Analysis

Jong-Yi Hong

Kyungnam Univ.,Woryeong-dong,Masanhappo-gu, Changwon-si, Gyeongsangnam-do, Korea
jyhong@kyungnam.ac.kr

Abstract

About half of the products and services have been developed based on the technology transfer. Although the institution has been established for support technology transfer in many countries, technology transfer has not been cultivated. Because of the lack of knowledge about the technology broker, the technology transfer has been limited. Therefore, in this research, the new method for diagnosing the technology transfer network is drawn. The method is comprised of phase 1(extracting the technology broker), phase 2(drawing the technology expert). The method in this research provides TTB(Technology Transfer Broker), TTH(Technology Transfer Structure Hole) and TTD(Technology donor). In addition, to reflect the characteristics and constraints of each organization, the method recommends the optimized path of the network from TTD to TTB and the optimized technical path in organization of TTB. By diagnosing the technology transfer network, the method provide chance to grasp the opportunity that can lead to technology innovation. Further, the method support TTR(Technology Transfer Recipient) to understand the connectable point of TTB within the technology transfer network.

Keywords*: Expert Recommendation Systems, Technology Transfer Network, Social Network Analysis, Technology Broker*

1. Introduction

The importance of technology transfer has been increased dramatically, because it is the key to effectively gain the technology for success of the enterprise [1]. It is possible to innovate a product and service if the new technology is transferred effectively from the technology donor to technology recipient [2-3]. About half of the products and services that have been developed are based on the technology transfer [4]. Development of new products through technology transfer is a driving force to lead the market [5].

Effective acquisition and utilization of technology is an important key to the success of companies. In the process from the start of the research and development to commercialization, it is possible to lead the world market if companies ensure the efficiency to gain the new technology. Radical development of the technology is rapidly changing the speed of product innovation. Technology innovation fosters to change of markets and products. Companies can't develop all of the technology to develop the product or service. As a result, the importance of technology transfer has been rapidly increasing. In fact, innovation of new product development and services of more than 50% have been made through the technology transfer. Market introduction of new products and services based on the technology transfer provides an opportunity to improve the profit and market share of the company. Since the importance of technology transfer is to increase, the concern about technology transfer in universities, government and research institutes have been growing continuously.

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Technology transfer has been variously defined in accordance with the purpose of research and academic disciplines. In the early studies on technology transfer, it was defined as the movement of technology between the organizations. Definition of technology transfer in previous studies focused on technology and defined as one of the flow of technology from the technology Donor to technology Recipient.

Recently the technology transfer is a shared process of two-way knowledge from a variety of technology donor to a variety of techniques recipient. The scope of technology transfer has been enlarged from the delivery of license and intellectual property rights to the delivery of knowledge, know-how and technology. Therefore, the definition of technology transfer is also expanded to cover a wide scope. The definition of technology transfer is a shared two-way process of knowledge technology, know-how, best practice and so on from the various technology providers to the various techniques recipient [4].

Although the institution has been established for support technology transfer in many countries, technology transfer has not been cultivated, because of technology transfer barriers [6]. The first of the barriers to inhibit technology transfer is the lack of knowledge of technology organization. For successful technology transfer, it must be the assumption that the technology recipient knows whether the technology organization has any technique. Even if the technology recipient needs to the specific technology in the new domain industry, the technology transfer would fail if the technology recipient does not extract the core technology donor and broker. Only the movement of technology licensing and intellectual property rights is impossible to apply technology to new product because the movement of technology as well as knowledge, applying the technique process, knowledge leveraging process, know-how and best practice are required for successful technology transfer. Therefore, the technology recipient should know the information about the technology broker that can mediate companies and technology donor.

The second barrier is the lack of information about technology expert. For the activation of the technology transfer, knowledge related with technology should also transfer. Tacit knowledge is more important than explicit knowledge, because the knowledge about technology transfer process, best practice and know-how are included in technology transfer. If the technology recipient understands the capabilities and role of technology exert in the organization of technology donor, but the transfer of tacit knowledge is possible. However, if inappropriate human resources for technology transfer are forced to participate, technology transfer would fail.

Technology transfer broker refers to the organization to perform the role of mediating to allow two-way communication at the center of the technology donor and technology recipient. Technology transfer broker supports the recipient to decide the effective technology donor and provide the information about technology donor and technology expert. Technology transfer broker has been called as agent, bridges or bridging Institution. In addition, most of the research related to the technology transfer broker has remained at a level to verify the need and effectiveness of technology transfer broker. Deriving a technology transfer broker is key success factor for cultivating technology transfer. However most researchers had verified the role and importance of technology transfer broker though a variety of cases. Because of lack of knowledge about the technology broker, the technology transfer has been limited [7-9]. The role of technology broker is as follows.

- Decreasing the barrier between technology donor and technology recipient
- Improving the speed of technological innovation and diffusion based on the understanding of the technology transfer network
- Supporting the technology commercialization of technology recipient
- Supporting the smooth technology transfer though removing the structural hole

- Diagnosing the bottlenecks and the hub in technology transfer network

In order to lower the barriers of technology transfer, it is necessary to technology transfer broker based on network analysis of technology transfer. Technology transfer network is the foundation for the technology transfer. The network construction of technology transfer is a key success factor for the technology transfer. The technology broker helps the technology recipient succeed based on the network analysis of technology transfer. Despite the importance of technology transfer broker for lowering barrier of technology transfer, the research related with extracting technology broker is insufficient.

The network of technology transfer should be diagnosed to extract technology transfer broker and technology expert in organization of technology transfer broker. In order to inform technology broker, it is necessary to diagnose the technology transfer network. However, the research related with network of technology transfer had been focused on the technical trading network. Most researches related with the technology broker have focused on the definition, role and effectiveness. Most research of the technology transfer network has remained to validate the efficiency and effectiveness of network. In this research, the author tries to derive the new method for diagnosing the technology transfer network and extracting the technology broker.

The remainder of this research is organized as follows. First, in section 2 we present a literature review of the technology transfer and technology transfer broker. The method for classifying the technology transfer organization based on social network analysis will be developed in section 3. The proposed method will be illustrated sub-section. Then, we conclude our study with a look at contribution and limitation.

2. Literature Review

Researches related with the evaluation of technology transfer are shown in the following table. They are classified into technology and knowledge in accordance with the evaluation subject of technology transfer. They are subdivided according to the evaluation method. A number of researchers in this area have focused on the technology value assessment. However, research to evaluate the technology transfer network is very rare. In addition, despite there is a need to comprehensively assess the technology transfer network, most researchers had developed the technology evaluation method.

Table 1. Research Related with the Assessment of Technology Transfer

Evaluation subject	Evaluation method	Related researches
Technology	Technology assessment model	[16, 17, 18]
	Efficiency or effectiveness assessment	[2, 19, 21]
	Path Analysis	[22, 23, 24]
Knowledge	Knowledge or expert	[4, 25, 26]

Researchers in the domain of technology transfer network have not focused on the technology transfer broker. They have focused on verifying the effectiveness and efficiency of technology transfer network. There are to verify the efficiency of investment in technology trading network [10-11] and to assess labor costs in the technology trading network [12]. Research related with technology transfer network is not intended to mostly focus on the network of technology transfer, but focus on verifying the effectiveness and efficiency of technology transfer network. To verify the efficiency of investment in technology trading network, the problem of labor costs in the technology trading network was solved.

Although some researchers had focused on technology transfer network analysis, they only derived the technology transfer network by using the subject relevance and

knowledge among enterprise. Tseng (2008) [13] is to graphically represent the flow of knowledge between countries to derive the mobile network of the patent, Bond *et. al.*, (2008) [14] provides a knowledge transfer network applied to the development of technologies and products. Lee *et. al.*, (2011) [15] also presented the model to select a technology provider through the minimization of the cost in the technology trading network. The technology transfer networks are configured with the knowledge and patents instead of the flow technology transfer between technology donor, technology transfer broker and technology transfer.

In addition, most of the research related to the technology transfer broker has remained to insist the necessity and effectiveness of technology transfer broker. To analyze the impact of technology transfer broker on the improvement of the diffusion and innovation of technology, the characteristics of the technology transfer broker organization was analyzed through the case study. The role of technology transfer broker from the point of view of technological innovation is also validated through the case study. In most research related to the technology transfer broker, the most effective technology transfer technology transfer broker capability and the need of technology transfer broker has been derived. To diagnose the network of technology, it should be derived to the core technology transfer broker of technology transfer network.

3. Research Method

The method for diagnosing the technology network transfer is shown as the following figure. The method is comprised of phase 1(Preprocess) and phase 2 (Diagnosis) [27]. The objective of the first phase is drawing the technology transfer matrix. In the second phase, it is an objective to derive the technology transfer broker based on classifying organization in the network of technology transfer.

The method provides chance to grasp the opportunity that can lead to technology innovation by analyzing and visualizing the technology transfer network. Further, the method supports technology recipient to understand the connectable point of an important technology broker and core technology expert within the technology broker organization.

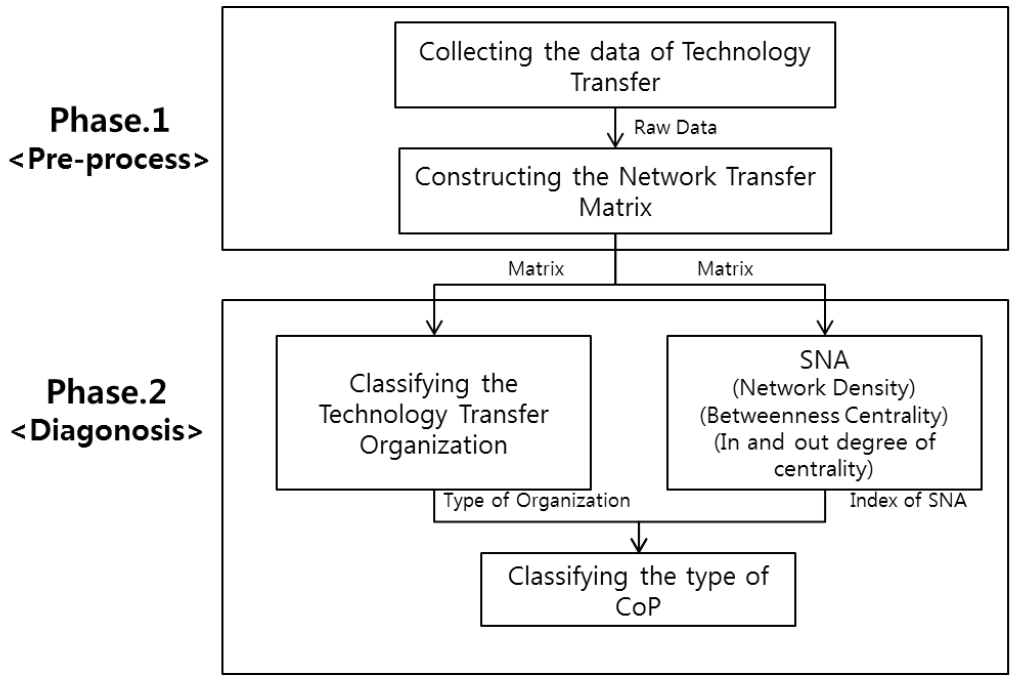

Figure 1. Research Method

3.1. Phase 1: Pre-Process

3.1.1. Step 1: Collecting the Technology Transfer: The technology transfer matrix consists of the relation between the technology transfer organizations. If the technology transfer activities have occurred, the technology transfer matrix will be made by inserting the number of knowledge transfer.

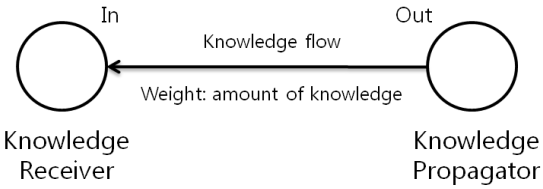

Figure 2. Knowledge Transfer between the Organizations

The row is the technology donors and the column is knowledge recipients in the N × N technology transfer matrix.

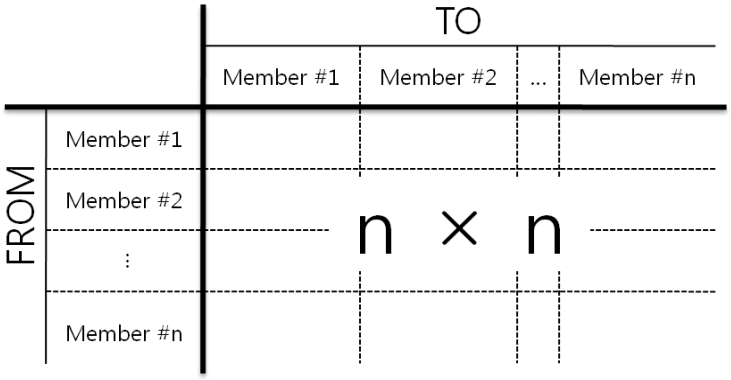

Figure 3. Technology Transfer Matrix

3.1.2. Step 2: Constructing the Network Transfer Matrix: It is needed to make the technology transfer matrix for analyzing the technology transfer network. The technology transfer matrix consists of the relation between the technology broker, technology donor and technology recipient. The row is the technology donor and the column is technology recipient in the N × N technology transfer matrix. If the technology transfer activities occurred from the technology donor to technology recipient, the technology transfer matrix will be made by inserting the number of technology transfer. The data to be inserted into the technology transfer matrix is obtained based on the analysis of the current situation and survey. If you have recently used the technology transfer to the development of new products and improvement of services for the three years of technology, technology recipient fill out technology recipient, the number of technical transfer and technology donor in the survey questionnaire.

In order to analyze the technology transfer network from the view of the whole and the parts, the technology transfer network is divided into the entire network technology transfer matrix(Full Network) and the partial network(Snowball Method & Ego-Centric Network). Because of the constraints of technology recipient, even though the competence of technology is relatively low, technology recipient chooses the technology providers in the same industry. Therefore, it is needed to construct a portion network. On the other hand, if the technology is required to solve the greater serious problem, highly specialized engineers and technology brokers are needed. To derive the technology broker, the full network should be drawn.

3.2. Phase 1: Diagnosis

3.2.1. Classifying the Technology Transfer Organization: In order to eliminate the barriers of technology transfer, it is necessary to diagnose the technology transfer network. The mediation activities of technology transfer broker play an important role in the technology transfer network. However, although technology transfer isolator and the hole in technology transfer network own the technology and the demand for technology transfer, they cannot play a role. Therefore, it is necessary to classify organization that contains the activities of technology transfer for presenting a differentiated strategy for each organization. By deriving the technology transfer broker, it is possible to facilitate the technology transfer and reduce the boundary between the industries between universities.

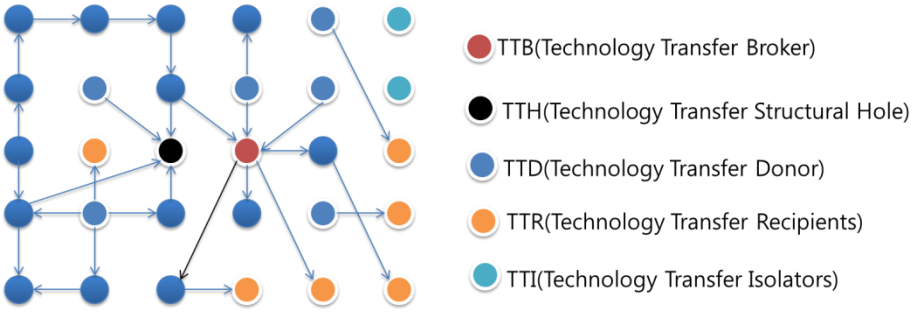

Figure 4. Classification of Technology Transfer Organization

- TTB(Technology Transfer Broker)
  - ✓ Important organization that plays a central role in technology transfer network
  - ✓ Organization that have a lot of technology, knowledge and processes about the transferred technologies
  - ✓ Performing the role of TTD and TTR
  - ✓ TTB is divided into inter-TTB and intra-TTB.
  - ✓ Inter-TTB: Not the same industry group, to perform the role of intermediary in the transfer of technology between the same industry group or the same country as the inter-TTB to perform the role of mediation in the time of
  - ✓ Intra-TTB: technology transfer between other industry groups or other countries by classifying to derive the intra-TTB.
- TTH(Technology Transfer structural Hole)
  - ✓ Organization that does not provide few technology but receive a lot of technology
  - ✓ Accepting just useless technology and not recreating technology by taking advantage of the transferred technologies
- TTD(Technology Transfer Donor)
  - ✓ Organization that provides aggressive technology
  - ✓ Organizations to perform the role of technical experts
- TTR(Technology Transfer Recipient)
  - ✓ Organization that uses technology of TTD rather than propagates the technology

- TTI(Technology Transfer Isolator)
  - ✓ Organization that has not been technology propagated and utilized with other organizations in the same industrial area although they want to use the technology of other organization

3.2.2. SNA: Basic indexes (network density, network centrality, In-degree, Out-degree and so on) in social network analysis are utilized to diagnose the activities of the technology transfer network. The following equations are used to classify organization.

- Network Density = $G_k = \frac{\sum\sum(Z_{ijk}+Z_{ijk})}{\frac{N(N-1)}{2}}$
- Betweenness Centrality = $C_B(P_m) = \frac{\sum\sum(\frac{g_{imj}}{g_{ij}})}{\frac{N^2-3N+2}{2}}$

3.2.3. Phase 3: Diagnosing the Technology Transfer Network: The efficiency and effectiveness of technology transfer are differed in accordance with the form of the technology transfer network. Furthermore, for understanding the technology transfer network at a glance, it should be extracted to classify the technology transfer network.

- Random Technology Transfer Network(RTTN)
  - ✓ RTTN is the most efficient network structure for the technology transfer. All of the actors in RTTN have evenly transferred the technology. They share the role of TTD and TTR.
  - ✓ In addition, the path for TTR is very short, because it is possible to transfer technology without a lot of the TTB. RTTN is the most efficient the technology transfer network.
- Hub-centered Technology Transfer Network(HTTN)
  - ✓ HTTN has the concentrated TTB. As a result, the burden and the bottle neck of the technology transfer is generated. HTTN is not efficient for technology transfer, because the specific TTBs account for a large proportion.
  - ✓ Thus, in the case of HTTN, it is necessary to re-organization of the technology transfer network through the relocation of TTBs.

4. Conclusions

In spite of technology transfer is the very important factor for the success of the enterprise; technology transfer has not been activated. Most research for the technology transfer activation, have been focused on claiming the establishment of the system, law and institute. The technology transfer from the institutes or universities to companies is not cultivated. It is needed to comprehensively evaluate the technology transfer from the point of view of technology transfer network. Furthermore, it is possible to cultivate the technology transfer through technology transfer network diagnostics and technology transfer broker derivation.

It is necessary to derive a technology transfer broker from the point of view of technology transfer network for lowering the barrier of knowledge about technology donor. The method in this research is not intended to simply take advantage of the social network analysis. In addition to the new performance indicator, the method presents a classification system of technology transfer organization from the point of view of

network analysis. According to TTB, TTH, TTD, TTR and TTI, organization's unique activation strategy was suggested.

It is necessary to develop the method for diagnosing the technology transfer network and recommend the TTB and optimal path. However, most researchers have tried to verify the role of TTB based on the case studies. Therefore, in this research, we derive the method for diagnosing the technology transfer network based on the social network analysis.

By diagnosing the technology transfer network, the method provide chance to grasp the opportunity that can lead to technology innovation. Further, the method support technology recipient to understand the connectable point of TTB within the technology transfer network.

However, the author's research has some limitations. Since the method is based on academic and theoretical theory, the proposed method should be verified through case studies. The method needs to be applied to the industrial case.

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Authors

Jong-Yi Hong, Assistant Professor in Kyungnam University. Main research topic: Management of Technology, Management Information Systems, Performance Evaluation, Knowledge Management