

## Research Article

### An Empirical Analysis on Food Mechanical Technology Transfer in Universities

Yi Zhang, Yuancheng Geng and L. Luo

Hubei Three Gorges Polytechnic, Yichang 443000, China

**Abstract:** This study aims to investigate the mechanism of food technology transfer of universities based on the patent licensing network. University is an important part in building an innovation-oriented country in China. University food technology transfer also plays an important role to promote economic and social development. In this study, the university food technology patent licensing network in Fujian province was taken as an example to analyze its network characteristics, inspect features of university food technology transfer and do an in-depth investigation between the universities and their inventors. Then the existing problems were analyzed to make relevant recommendations to improve the ability of university food technology transfer. The empirical analysis results show that (1) it needs to complete the university intellectual property management system, (2) to change the functions of university management office, (3) to change the teacher evaluation system, (4) to complete the technology transfer agency market and (5) to increase the government supports.

**Keywords:** Food technology transfer, knowledge creativity, patent licensing network

#### INTRODUCTION

University has a large number of laboratories and commitment of many research projects and has also made extensive studies results, which strongly support the China's innovative national strategy of constructing an innovation-oriented country, the main output of these laboratories and research projects are papers, however, patent applications also greatly increase, such as Zhejiang University, ranked in the first place of patent applications, its application number has reached 24,715 at the end of 2013. Meyer (2002) considered that the output of scientific research is articles and technical innovation outputs is patents. Through implementing, licensing, transferring and other forms, patents can apply their technologies and thus to create value for society. General universities themselves are not directly involved in economic activities. They need to license these patents or transfer to other organizations to realize the economic value of their technology.

Research on food technology transfer in universities focuses on two aspects, the macro management and micro mechanism, among which, macro-management include organization (Hoppe and Emre, 2001; Siegel *et al.*, 2003), operation mechanism (Thursby and Kemp, 2002; Friedman and Silberman, 2001) and performance (Powers, 2004) of food technology transfer in universities; micro aspects is from the perspective of the knowledge flowing to inspect knowledge flowing mechanism (Mansfield, 1998; Lowe, 2006) in the process of technology transfer

in universities and the effects of knowledge flowing on food technology transfer (Tijssen, 2001). In the process of studying on the knowledge flowing in universities, citation analysis method (Jaffe and Trajtenberg, 1999) and social network analysis method plays an important role.

In the history of the development of social network analysis, Barnes (1954) firstly took the lead in a more rigorous and analyzed way to use concept of network, then Bavelas (1950) studied on the form feature of centrality in network and later Freeman (1979) and Scott (2000) enriched the concepts and methods of social network analysis. The use of social network analysis is very extensive (Sorenson, 2003), for example, Droege *et al.* (2003) studied the relationship between property of social networks and tacit knowledge diffusion. Brechi and Lissoni (2005) and Singh (2005) use patents citation to demonstrate that social proximity between invention of human cooperation network is basic motion of knowledge flowing. Zander and Kogut (1995) considered that interpersonal networks is an important way to the spread of knowledge and information. Fleming *et al.* (2007) also pointed out that contacts between patent inventors and co-operators can make their information deliver to someone else. Hong and Su (2012) use social network analysis methods to build knowledge flowing network from university to the enterprise. Wassermann and Faust (1994) considered that social network analysis is based on the assumption that the importance of the interaction between interaction unit, contact is defined as a connection between the units, this

connection is also a fundamental part of the network theory.

Patent license includes the licensor and the licensee, the licensee contacts with licensor through the way that licensor give a piece or a few pieces of patent licensing to licensee and this contact has direction that point to the licensor from the licensee. This can constitute a directive multi-value patent license network, among them, the licensor and the licensee is defined as a unit, the number of patent licenses is defined as the direction of the contact. We can use this patent license network to study relationship between these units. However, up to date very limited work has been done to address the problem on the mechanism of food technology transfer of universities based on the patent licensing network. It is very urgent to carry out researches to inspect the mechanism of food technology transfer of universities.

This study aims to investigate the mechanism of food technology transfer of universities based on the patent licensing network. The patent licensing network in university food technology transfer was built to analyze its network characteristics and investigate the relationship between the universities and their inventors. Lastly, based on the existing problems, some useful recommendations have been proposed to improve the ability of university food technology transfer.

**MATERIALS AND METHODS**

According to Chinese patent law, patent license contract must be filed in the State Intellectual Property Office. In patent licensing contract, one record number of contracts can contain one patent or multiple patents and one patent can be permitted by one licensee or multiple licensees, of course, one patent may contain multiple patent holders, namely, multiple licensors. Assuming that patent license conditions is shown as Table 1, we only extract the licensors A's patent license contract, who has three copies of the patent license contract (T1-T3), where T1 contains patent P1, T2 contains patent P1 and P2, T3 contains patent P3, P1 and P2 are licensed to Licensee B, P3 and P4 is only one licensee person, C and D. This constitute the 4 by 4 matrix  $A_{ij}$ , number 2 in matrix shows that there are 2 pieces of patent licenses from  $A_{12}$  to  $A_{11}$ , licensor A belongs to region  $R_A$ , licensees are subject to B-D, region  $R_B$ ,  $R_C$  and  $R_D$ . Region of licensors also constitutes a 4 by 4 matrix  $R_{ij}$ , number 2 in matrix shows that there are 2 pieces of patent licenses from  $R_{11}$  to  $R_{12}$ . The entire patent license network can be represented as Fig. 1. In Fig. 1, the University a license patent to two organizations, geographic region  $R_A$  to  $R_C$  has one time knowledge flowing, this network is a directed graph; numerical value in the figure indicates the number of patent licenses. This study will build a

Table 1: The situation of patent licensing

Contract number	Patent number	Licensee	Licensor	Licensee' area	Licensor' area
T1	P1	A	B	$R_A$	$R_B$
T2	P2	A	B	$R_A$	$R_B$
T2	P3	A	C	$R_A$	$R_C$
T3	P4	A	D	$R_A$	$R_D$

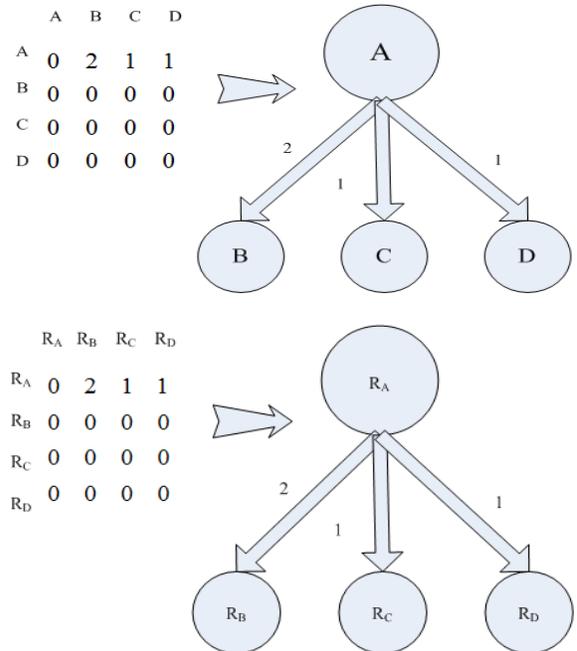


Fig. 1: The patent licensing network

university patent license network based on above-mentioned method.

**RESULTS AND DISCUSSION**

**Results:** In this study, Fujian University is selected as the research object, according to information of food technology patent license contract registration in the State Intellectual Property Office collates relevant statistics that obtained a patent license, Fujian Province has a total of 122 pieces of patent licenses, involving 11 universities, namely, Fujian University of Technology (FJUT), Fujian Agriculture and Forestry University (FAFU), Fujian Academy of Agricultural Sciences (FAAS), Fujian Normal University (FJNU), Fuzhou University (FZU), Huaqiao University (HQU), Jimei University (JMU), Xiamen University (XMU), Xiamen University of Technology (XMUT), Fujian Institute of Research on the Structure of Matter, Chinese Academy of Sciences (FJIRSMCAS). Among these patent licenses, 97.54% of the licenses are an exclusive license type, including 95 invention patents, 27 utility model patents, design patents. The overall network characteristics are shown in Table 2.

As can be seen from Table 2, the network size of XMU reached the maximum of 21 and MJU and XMUT only had one connection, the Degree of FJNU is the maximum of 25, the minimum is XMUT is 1. After computation, the mean degree of the whole network is

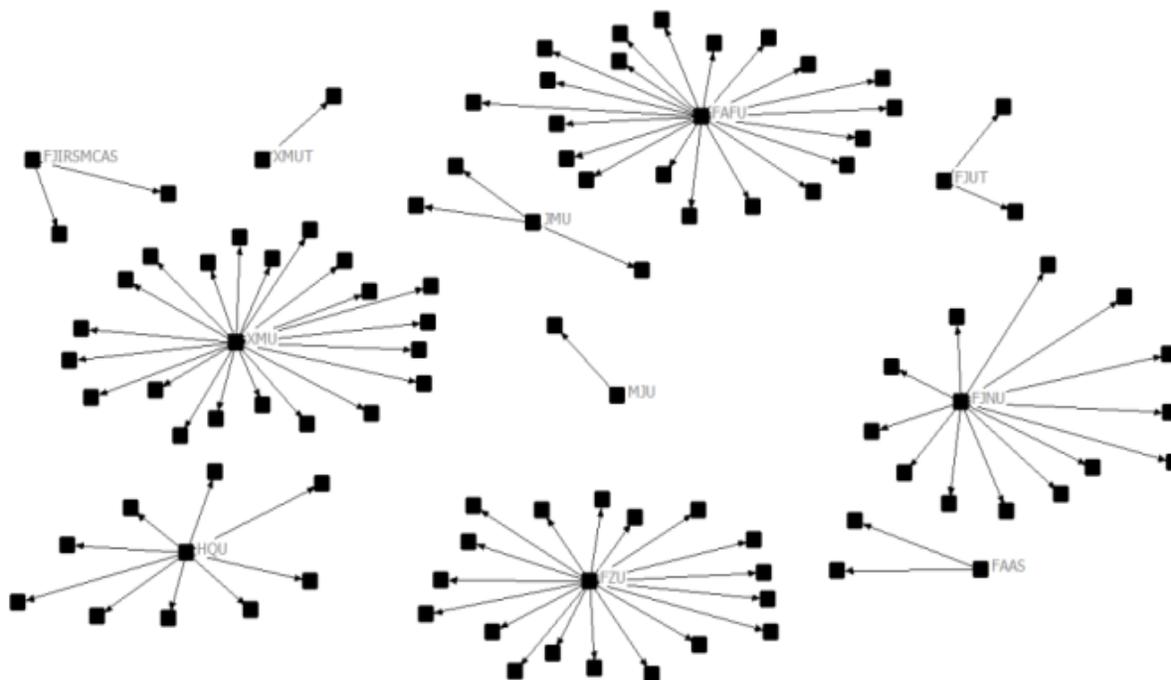


Fig. 2: The whole patent licensing network

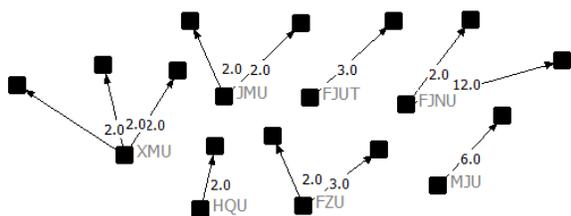


Fig. 3: The whole patent licensing network with connection number greater than one

When selecting the connection number is greater than one, the whole network left XMU, JMU, FJUT, HQU, FZU and MJU these 7 universities, which had 12 licensee, mostly had only 2 licenses, the most is FJNU, which had licensed 12 patents to the Fuzhou Minyou Jixin Digital Technology Co., Ltd, the second is MJU had licensed 6 patents to the Fujian Baode Group, their status as shown in Fig. 3.

All these universities only located in Fuzhou city, Xiamen and Quanzhou city of Fujian Province and then examined its geographical radiation effects, according to the method of Fig. 1, we got the following networks, shown in Fig. 4 to 6. Table 3 lists the statistical results.

As can be seen from Fig. 4 to 6 and Table 3, these three areas mainly licensed their patents to its own cities, mostly in Fujian Province, where Fuzhou had licensed 8 patents to the other provinces, only Guangdong Province had twice, the other 7 provinces are only had one time, Xiamen and Quanzhou cities had 6 licenses to the outside provinces, each one had one time, the distribution of these outside provinces was scattered. Overall, the economy of these provinces were developed, such as Beijing city, Guangdong city, Shanghai city, Zhejiang city and Jiangsu city, which showed that regional patent licensing more concentrated in location, licensing to the local province carried out the majority, the outside provinces mostly were developed areas.

Therefore, the technology transfer of Fujian universities was scattered, Individual difference was bigger, concentrated in Fuzhou, Xiamen and Quanzhou these three cities, the licensees were also scattered, but

Table 2: The network descriptive statistics

	Size	Degree	NrmDegree	Share
FJNU	13	25	2.042	0.104
XMU	21	24	1.961	0.104
FZU	18	21	1.716	0.087
FAFU	20	20	1.634	0.087
HQU	9	10	0.817	0.042
MJU	1	6	0.490	0.025
JMU	3	5	0.408	0.021
FJUT	2	4	0.327	0.017
FAAS	2	2	0.163	0.008
FJIRSMCAS	2	2	0.163	0.008
XMUT	1	1	0.082	0.004

Network Centralization = 1.89%; Heterogeneity = 4.41%; Normalized = 3.47%.

Table 3: The area patent licensing statistics

Area	Local city	Local province	Outside provinces	Total
Fuzhou	30	73	8	81
Xiamen	13	26	4	30
Quanzhou	5	8	2	10

2.33 and the density is 1.3043, indicating that this network is relatively dispersed. The whole patent licensing network is shown in Fig. 2.

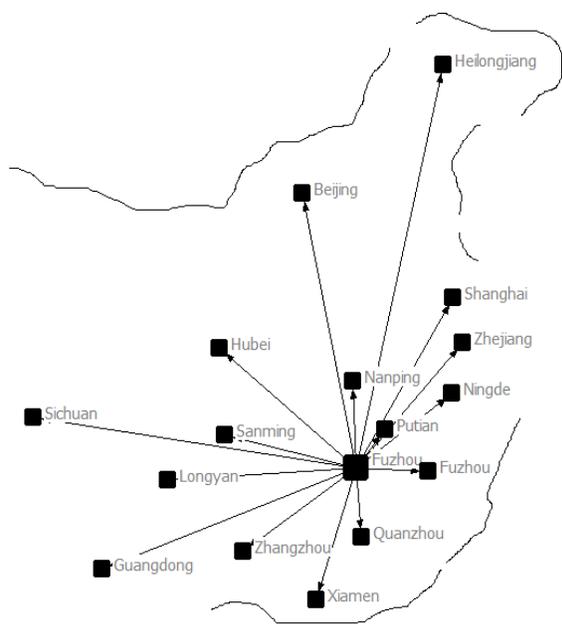


Fig. 4: Fuzhou geographical radiation effect

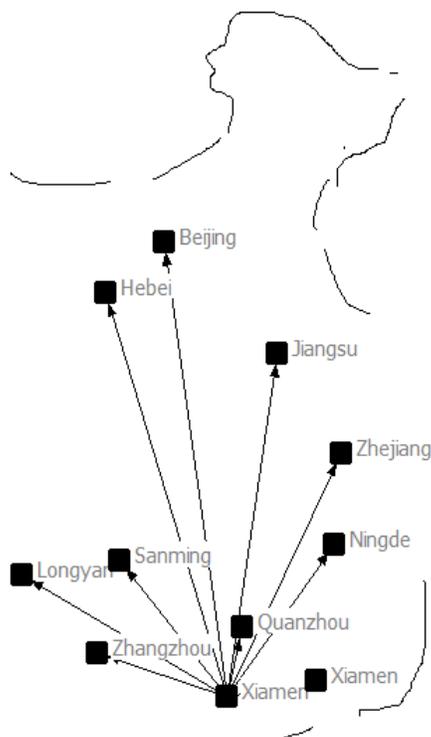


Fig. 5: Xiamen geographical radiation effect

the concentration of some individuals were very high, the licensees' areas mainly concentrated in the local province, the outsides provinces were very scattered.

**Analysis:** This study made a survey to the above 11 universities and its inventors, of which provided 300 copies to these inventors, recovered 148 copies, the rate

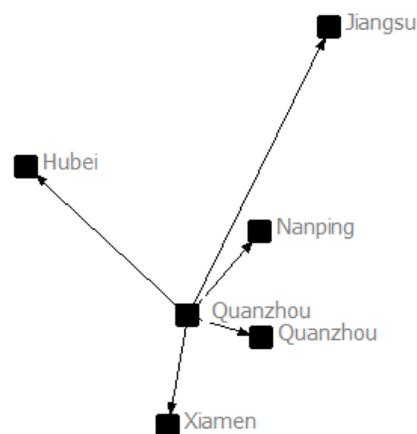


Fig. 6: Quanzhou geographical radiation effect

was 49.33%. According to the result, we examined the situation of its patents, patent licensing, technology transfer management system and the problems of technology transfer, then made the recommendations to promote university technology transfer.

**The basic situation:** According to the questionnaire, these universities have a total of 3,638 patents, the rate of patent licensing is 3.35%, if coupled with the self-use and transfer, the number reaches 279 and the implementation rate is 7.67%. The management agencies believe that only 21.43% of its university staff pays attention to the patent technology transfer, the attitude of the rest is general understanding, which showed that: the majority of the staff does not well understand the patent technology transfer, need to improve their ideology, the result as shown in Table 4.

As can be seen from Table 4 that staff approve the patent implement, technology services and the patent transfer, but also want to do the above things, but if they use too much time on patent implement, which will reduce the time on teaching and research, so if the university will enact suitable policy to solve above problem, 42.86% of the staff wants to help companies to effectively patent implement. Since universities and staff are willing to use the patent, the reasons of the patents have not been used as shown in Table 5.

As can be seen from Table 5, the most important reason for these patents not to be used is that the inventors could not contact the investors or manufacturers, the following reason is the need for technical layout. The most choices of the second and the third reason is the patent market opportunities immature, which indicate that the search of buyers and licensees is the most important, which requires the government to enhance the construction of patent trading platform, to provide more opportunities for inventors.

Table 4: The survey of its willingness to participate the use of food technology patent by staff

Choices	Number
If the university provided relative policy, staff want to help companies effectively implement patent	6
Do not want to participate the patent implementation, but can provide the general technology services	2
Wishes to sale	3
Wishes to patent licensing to implement by the company itself	2

Table 5: The reasons of food technology patents have not been used

Reasons	First	Second	Third
Can produce to the product, but to prevent existing products to be eliminated	4	2	0
Just to meet the administrative requirements (assessed, concessions, etc.)	4	0	2
Cannot contact the investor or manufacturer	69	7	5
Inadequate patent protection, no profit	3	19	6
The need for technical layout	23	13	4
The patent market opportunities immature	14	35	19
Improved patent, the implementation of the whole technology will involve the infringement	4	2	2

Table 6: Food technology patent transfer and trading channels

Channels	Num	Channels	Num
Involved in the technical exhibition or trade fair	11	Law agency	0
Patent agency	6	Patent technology service company	4
Patent trading platform	5	Friends	4
Patent transfer office owned by university	4	Inventor themselves	3

Table 7: The difficult in the food technology patent transfer and licensing

Choices	Number
Patent trading platform market is underdeveloped	10
Patent product is hard to manufacture	9
Patent value is hard to assess	7
Hard to find buyers	6
Low patent quality	6
The income of service invention is difficult to divide	3

Table 8: The difficult of food technology patent implementation

Choices	First	Second	Third	Total
Difficult to industrialization	46	8	8	62
Lack patent trading platform	17	15	9	41
High cost of patent trading	1	8	6	15
Low patent quality	4	12	7	33
Lack patent managers	5	21	21	47
Intentionally patent infringement	1	2	5	8

The usages of patents owned by the inventors are manufacture products and transfer (both 23.65%), license to manufacture products (20.27%), there are a few other selections, such as advertising (7 choices), discounted shares (2 choices) and bidding (1 choice), which indicate that although the university patents mostly used in the manufacture, transfer and licensing, but also had the other ways.

**Management mechanism:** On these universities surveyed, only one university did not set any management office and managers, HQU and FAFU had the intellectual property management department, the other 71.42% were managed by its Science and Technology Department or the relevant department. Only two universities did not establish the patent management rules and regulations, FAFU, HQU, FJNU, FZU and XMU had the intellectual property management rules and regulations and also had the separate patent management rules and regulations, the

other 6 universities put the patent management regulation into the intellectual property management regulations.

There are 8 universities have the incentive measures for the service invention, which are reflected in income distribution system, on the survey of income distribution system, only 57.14% have such system, the average rate of income to the inventors is 60%, the highest is FJNU of 80%.

As can be seen from Table 6, the largest channel to patent transfer and trading is involved in the technical exhibition or trade fair, there are 4 universities have their own patent transfer offices, which are XMU, FZU, HQU and XMUT, the channel of friends has selected 4, one thing to note is that patent agency are ranked second, but also the most trusted intermediary, but the law agency has no choice, indicating: University will look for the specialized intermediaries, has the relatively high ideology of patent.

**The difficult in technology transfer:** The survey of the difficult in the patent transfer and licensing is shown in Table 7. The most difficult is the patent trading platform market is underdeveloped, the following are the patent product is hard to manufacture, patent value is hard to assess, hard to find buyers, low patent quality and the income of service invention is difficult to divide from university to inventor.

The survey of the difficult of the process from the patent application to implementation is shown in Table 8.

As can be seen from Table 8, the most difficult is hard to industrialization, the following are lack patent managers and lack patent trading platform, the two major choices by inventors to the first difficult are hard to industrialization and lack patent trading platform,

Table 9: The major problems of food technology patent use

Choices	First	Second	Third	Total
Lack leadership attention	6	2	6	14
The relevant rules and regulations are not perfect	15	17	8	40
Lack of intellectual property management funds	24	8	19	51
Lack the necessary guidance to the intellectual property management rules and regulations	11	11	3	25
Lack intellectual property managers	17	14	10	41
Lack intellectual property use and protection ideology	1	8	4	13
Lack the market information	35	26	14	75
Lack the motivation of staff to patent use	5	9	9	23
The main task of teachers is to research and teaching, lack the time in patent transfer	22	3	20	65
Low evaluation of intellectual property	4	12	34	50

Table 10: The supports wanted from government

Choices	Number
Provide fund to patent implementation	14
Tax relief for the patent use income	13
Provide patent trading platform	12
Provide public information	12

Table 11: The measures provide from government

Choices	Number
Provide fund for the patent implementation	114
Contact the appropriate manufacturer or the investors for patent product	106
Complete the function of patent information trading service platform	98
Make clear income distribution policy	80

which shows that the patent industrialization is the most difficult in the patent implementation, we should provide more support in this area and the personnel training.

In the patent use process, only 11.49% of inventors use the agency, the inventors' attitude to the agency are 10.14% think it is very important, 4.73% believe that is not important, 16.22% think it is general importance, indicating that the inventor is not well in use of agency, because the agency has the important role in search buyer, afford professional advice in the patent trading, which should strengthen the cooperation between university and agency. In this patent use process, the inventors believe that there are the following major problems, as shown in Table 9.

As can be seen from Table 9, the most serious problem is the lack the market information and ranked second choice is the main task of teachers is to research and teaching, lack the time in patent transfer, which total number has reached 65, the following choice is lack of intellectual property management funds, there are 34 inventors selected low evaluation of intellectual property in the performance, constraints and incentives are insufficient in the third difficult problem.

**Government support:** In the survey of the supports need from government for universities, the ranked first is to provide the fund to patent implementation for themselves, the selection of choices of tax relief, provide patent trading platform and provide public information are also more than 10, indicating that the government could provide a lot of supports to the university patent use and the results as shown in Table 10.

In the survey of the supports need from government for inventors, the ranked first is fund support; the following choices are to contact the appropriate manufacturer or the investors for patent product, to complete the function of patent information trading service platform and to make clear income distribution policy, the results as shown in Table 11.

## CONCLUSION

In summary, the patent licensing rate of universities was 3.35%, plus its own implementation and transfer reached 7.67%, through investigate and analysis the questionnaires of universities and inventors, we can draw the following conclusions and recommendations:

- Need to complete the university intellectual property management system because there are less than 50% of universities that have the income distribution rules for food technology patent use, which need to make more intellectual property management rules and regulations for all the universities
- Change the functions of university management office and suggest that:
  - Allocate a certain percentage of food technology patent transfer income to the management officers to improve their enthusiasm:
  - Leading the professional food technology transfer managers to search the market
  - Provide training for the university staff, enhance their ideology, in order to enhance the food technology transfer initiative and ability
- Change the teacher evaluation system
- Complete the food technology transfer agency market and recommend that:
  - Improve the functions of intellectual property services platform
  - Change the business model of the food technology trading and patent exhibition centre and enhance the initiative service capabilities to provide the suitable patent information for the technology demand side and to build a investor team with knowledge of technology, market, investment, intellectual property, for intellectual property value-added service
- Increase the government supports

## ACKNOWLEDGMENT

This project is supported by the Scientific and Technological Research and Development Project of Yichang City (No. A13-302b-02) and Hubei Education and Science Research Project (Title: Innovative Talents Development in Vocational Colleges Based on TRIZ).

## REFERENCES

- Barnes, A., 1954. Class and committees in a Norwegian Island Parish. *Hum. Relat.*, 7: 39-58.
- Bavelas, A., 1950. Communication patterns in task-oriented groups. *J. Acoust. Soc. Am.*, 22: 725-730.
- Brechi, S. and F. Lissoni, 2005. Cross-firm inventors and social networks: localised knowledge spillovers revisited. *Annals d' Economie et de Statistique*, 80: 1-29.
- Droege, S., B. Hoobler and M. Jenny, 2003. Employee turnover and tacit knowledge diffusion: A network perspective. *J. Manage. Issues*, 15(1): 50-64.
- Fleming, L., C. King and A. Juda, 2007. Small worlds and regional innovation. *Organ. Sci.*, 18: 938-954.
- Freeman, C., 1979. Centrality in social networks conceptual clarification. *Soc. Networks*, 1(3): 215-239.
- Friedman, J. and J. Silberman, 2001. University technology transfer: Do incentives, management and location matter. *J. Technol. Transfer*, 328: 17-30.
- Hong, W. and Y. Su, 2012. The effect of institutional proximity in non-local university-industry collaborations: An analysis based on Chinese patent data. *Res. Policy*, 42(2): 454-464.
- Hoppe, C. and O. Emre, 2001. Intermediation in Innovation: The Role of Technology Transfer Offices. Universitat Hamburg, Mimeo.
- Jaffe, B. and M. Trajtenberg, 1999. International knowledge flows: evidence from patent citations. *Econ. Innov. New Technol.*, 8(1): 105-136.
- Lowe, R., 2006. Who develops a university invention? The impact of tacit knowledge and licensing policies. *J. Technol. Transfer*, 31: 415-429.
- Mansfield, E., 1998. Academic and industrial innovation: An update of empirical findings. *Res. Policy*, 26: 773-776.
- Meyer, M., 2002. Tracing knowledge flows in innovation systems. *Scientometrics*, 54(2): 193-212.
- Powers, B., 2004. R&D funding sources and university technology transfer: What is stimulating universities to be more entrepreneurial? *Res. High. Educ.*, 45(1): 1-23.
- Scott, J., 2000. *Social Network Analysis: A Handbook*. Sage, UK.
- Siegel, S., D. Waldman and A. Link, 2003. Assessing the impact of organizational practices on the relative productivity of university technology transfer offices: An exploratory study. *Res. Policy*, 32(1): 27-48.
- Singh, J., 2005. Collaborative networks as determinants of knowledge diffusion patterns. *Manage. Sci.*, 51(5): 756-770.
- Sorenson, O., 2003. Social networks and industrial geography. *J. Evol. Econ.*, 13: 513-527.
- Thursby, J. and S. Kemp, 2002. Growth and productive efficiency of university intellectual property licensing. *Res. Policy*, 31(1): 109-124.
- Tijssen, W., 2001. Global and domestic utilization of industrial relevant science: Patent citation analysis of science-technology interactions and knowledge flows. *Res. Policy*, 30: 35-54.
- Wassermann, S. and K. Faust, 1994. *Social Network Analysis: Methods and Applications*. Cambridge University Press, Cambridge.
- Zander, U. and B. Kogut, 1995. Knowledge and the speed of the transfer and imitation of organizational capabilities: An empirical test. *Organ. Sci.*, 6: 76-91.