The Status Quo and Supply Prediction for Suzhou Sci-Tech Innovative Talents

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Abstract—**Sci-tech innovative talents are special groups of talents, and have gradually been attached great importance by most countries in recent years. Now the Sci-tech job of Suzhou city has prominent achievements, and is leading in Jiangsu province and even in China, which will be useful implications to other provinces and cities. In this paper, the definition of sci-tech innovative talents is explored first, and the supply of Suzhou sci-tech innovative talents is predicted based on GM (1, 1). Lastly, some conclusions are discussed and suggestions are proposed.**

Keywords—**Sci-tech Innovative Talent, Grey System Theory, Supply, Forecast**

I. INTRODUCTION

Sci-tech innovative talents (STIT) are special groups of talents, and their quantity and quality promote scientific and technological progress to a great extent, and have gradually been attached great importance by most countries in recent years [1]. Suzhou is a city in the province of Jiangsu, China. It has also been an important centre for China's silk industry and continues to hold that prominent position today. The technology job of Suzhou has made remarkable achievements. On the whole, it is leading in Jiangsu Province and even China [2]. According to the statistics of Science and Technology Department of Jiangsu Province (JSSTD), it has ranked second for years. Accompanied by the rapid development of science and technology, the team of Suzhou STIT grows gradually, and has formed a high and hierarchy innovative talents, which provides a new impetus and intellectual support necessary for the sustainable development of Suzhou. The rules of economic development also determine STIT are the primary resources for the development of Suzhou under the new era, so it's of great significance to build the STIT team. In addition, it will be a useful implication to other cities and provinces.

At present, there are no common accepted concepts of innovative talents and STIT. Generally, it's agreed: to judge whether a person belong to innovative talents, the standard does not lie in his career, not lie in the position and qualifications high or low, but whether he will be innovation, whether as innovative as our own duty, be good at study and research and practice, and achieved outstanding innovations[3-5]. We believe that STIT have a high scientific and technological innovation capacity, long-term sustainability to engage in scientific discovery and research and development activities, and their performance are mainly reflected in a certain Scientific and technological achievements. They promote scientific& technological progress and social development.

In China, it has not yet statistical significant terms for STIT. As for "China Statistical Yearbook" and "Statistical Yearbook of Science & Technology of China," 3 relevant groups correspond to the group of STIT: staff of scientific and technological activities (T&S S), staff of research and experimental development (R&D S), staff of scientists and engineers(S&E S). T&S S are those who are engaged in or participate in scientific and technological activities directly, as well as scientific and technological management and service providing staff; S&E S are those who graduate from university with high academic qualifications or above, or are with senior primary professional title, they are core of science and technology staff; R&D S are those who are engaged in innovative scientific research personnel. In short, T&S S, R&D S and S&E S are the mainstay of STIT, reflecting the structure and hierarchy of STIT.

In this paper, the Status Quo of Suzhou City STIT is analyzed thoroughly based on the definition of STIT, and the future status is predicted by GM (1, 1). At last, the conclusion and suggestion are given.

II. THE STATUS QUO OF SUZHOU STIT

Suzhou has made remarkable achievements on cultivation of STIT, with the dramatic increase of both the quantity and quality. According to "The Monitoring Results of Jiangsu Province of scientific and technological progress and technology statistics Statistical Bulletin", "Suzhou Statistical Yearbook" and "Suzhou Science and Technology Overview" [6-8], it's found that the cultivation of Suzhou STIT shows the following characteristics:

A. The Scale of Suzhou STIT Growing Gradually

For a long time, Suzhou CPC Municipal Committee and Municipal Government attaches great importance to human resources work vigorously and strengthen the construction of human resource procession, and always put the implementation of " reinvigorating city through human resource development " strategy before "treble implementation", Suzhou is becoming a

hot spot for talent from home and abroad, resulting the number of innovative talents of science and technology increases rapidly. By of the end of 2006, there 518,631 professional and technical personnel in Suzhou, of whom 22,552 have advanced titles, 104,872 have intermediate titles, compared to 2001 increased by 70.87%, respectively, 60.42% and 46.73%. The number of personnel engaged in scientific and technological activities of large and large-medium industrial enterprises of Suzhou was 20,650 in 2002 and increased to 40,961 by the end of 2006.

B. The Quality of Suzhou STIT Improving Steadily

As the quantity of the number of personnel in scientific and technological innovation, at the same time, quality is also improved steadily. First of all, the absolute number and the percentage of scientists and engineers increases substantially, in 2002 the number of scientists and engineers of large and large-medium industrial enterprises in Suzhou is only 5670, which increased to 24,894 in 2006, 4.4 times of that in 2002. Secondly, the effort of introducing and cultivating high-level talents has also made remarkable achievements. In recent years, the number of people who applied for "333 high-level personnel" is 126, while the number of those scientific and technical personnel who applied for "the province to introduce high-level innovation incubator program" is 188, emerging a group of subjects from science and technology leaders at home and abroad.

C. The Innovative ability of Suzhou STIT Improving Sharply

Patents can reflect the achievements and efficiency of Sci-tech job very well. In the year 2000, the quantity of patent applications and granted is 2021 and 1922; while in 2006, the number grows into 12874 and 4855. In addition, the numbers of patent applications and patents granted of professional and technical personnel (PTP) also increased substantially. For example, in the year 2001, the number of applications is 87.12 per ten thousand PTP, and the number of granted is 57.43 per ten thousand PTP; in 2006, the numbers are 248.23 and 93.61 separately, increasing with 185% and 63% compared to 2001.

D. The Technology Investment of Suzhou STIT Increasing Continuously

With the development of economic, Suzhou increases the fund for science and technology continuously. The total amount of fund and the expenditures for research and development, such as the introduction of science and technology are achieved fairly rapid growth, one of the total funding, research and development expenditures, respectively, an increase of 350% and 460%. In 2002, Suzhou large and large-medium industrial enterprises in science and technology activities in science and technology personnel per capita funding for 160,700 RMB, and in 2006 grew to 361,300 RMB. Suzhou R&D funding is a significant increase in 2001 to 1,056,170,000 RMB, in 2007, increases to 9.69 billion RMB, are 9.17 times in 2001. The rapid growth of economic development and the investing for science and technology of Suzhou lay a solid economic foundation for the scientific and technological innovation activities.

E. The Policy System of Suzhou STIT Perfecting Relatively

Around the requirement "try to make Suzhou a city which is first choice for talents, the best city for talents to innovate and carve out" and other requirements and goals, Suzhou has formed the pattern that organization department take the lead position and the overall efforts, each department take its own work; Suzhou enacts policy of talents, at the same time, increases capital investment for talents. The relatively perfect system of personnel policies and the strong financial safeguards have attracted a lot of technological innovative talents. Suzhou, in 2002, introduced various kinds of professional and technical personnel more than 30 thousands, in 2007, introduced 76 thousands professionals of college or higher, of whom 344 are doctors, 2984 are masters, 533 are students returned after having studied abroad.

F. The Research Cooperation Deepening Successively

In order to alleviate the inherent lack of resources of higher education, Suzhou CPC Municipal Committee and Municipal Government plans to build the Suzhou Higher Education District and the Suzhou International Education Park, University of Science and Technology of China, Nanjing University, Renmin University of China, Xi'an Jiaotong University, Fudan University and several other colleges and universities in more than ten successive assigned to higher education area; WenZheng College of Suzhou University, Suzhou College, Suzhou Art & Design Technology Institute and other 12 Higher education institutions have settled, enhancing the capacity of cultivation and supply high-level talent and highly skilled professionals. The city's various types of enterprises with more than 100 institutions of higher learning, scientific research institutes has been set up over 250 research consortium, having applying more than 1000 cooperative projects. In particular, the Chinese Academy of Sciences, Suzhou Institute of Nano and Nano-Bionics, Industrial Technology Research Institute of Jiangsu Province, Jiangsu Iron and Steel Institute has been included in the province, "Eleventh Five-Year" significant technological infrastructure construction projects. The depth of research cooperation, scientific and technological talents Suzhou building provides an important platform.

G. The Service System for Suzhou STIT Completing Increasingly

In recent years, Suzhou actively has promoted innovation and entrepreneurial talent platform. Xuzhou current start-up service agencies achieve the 7 District 5 city-wide coverage, the city's various types of technology-based business incubator institutions has reached 27, one of eight state-level, provincial level 6, hatching breakthroughs one million square meters area. Both the quantity and size is in the first in Jiangsu Province. National characteristics, the city has 10 industrial base, accounting for a quarter of the province; successively completed the construction of the Suzhou Industrial Park IC design and software test platform, Suzhou Hi-tech Zone to create a platform of new drugs, Wuzhong District Laboratory Animal Service Center 10 provinces level of public technology service platform to enterprises as the mainstay, research closely with the technical innovation system is basically formed.

III. THE SUPPLY PREDICTION MODEL OF SUZHOU STIT

A. The Historical Data of Suzhou STIT

The supply prediction of STIT requires the statistic data with regard to T&S S, and S&E S. From statistics, it shows that large-medium industrial enterprises play a leading role in both technical innovation talents and the cost of R&D investment proportion. Therefore, we separately forecast T&S S, R&D S, T&S S and S&E in large-medium industrial enterprises. According to "Jiangsu Technological Progress Monitoring Statistics Results and Statistical Bulletin", "Suzhou Statistical Yearbook" and "Suzhou Technology Overview", the statistics about Suzhou STIT during the year of 2002 to 2007 are showed in table 1.

TABLE I.　　2002-2007 SUZHOU STIT

Year	T&S S	R & D S	Large and large-medium industrial enterprises	
			S&E S	S&E S
2002	31603	11425	20650	5670
2003	34619	12871	22518	5858
2004	43058	14317	29337	18456
2005	50002	18566	43464	25360
2006	49190	17396	40961	24894
2007	65201	26341	61845	36096

B. The Modeling Principle for Suzhou STIT Prediction

Supply prediction is a prediction of the volume of STIT at the end of the forecast period. The natural growth and flow of STIT have led to changes in STIT [9]. Natural growth here refers to the changes of STIT in quantity which caused by the cultivation of local schools, enterprises and society. Therefore, the capacity of STIT which are at the end of the forecast period depends on three factors: first, the total STIT at the beginning of the forecast period; second, talents cultivation capacity of the local schools, businesses and community; third, the net inflow of IT professionals volume during the forecast period, net inflow here refers to the balance of inflow and outflow of talents in STIT.

Because of the regional economic development, personnel policies, as well as technological advances and other factors, the volume of net inflow of IT professionals have some uncertainty, so the prediction from this perspective will have greater inaccuracy [10]. In addition, the history statistics of STIT are relatively inadequate; it is difficult to reflect the rules of data changes, so it is a great challenge to predict the supply with time-series prediction method.

Gray system theory study objects characteristic of "poor information" and "small sample" with uncertainty, correctly describe and effectively control system by generating valuable information through some information, and GM (1, 1) has been applied in various areas of practical applications of gray theory [11]. In this paper, we treat the supply system of STIT as a gray system, and use the model of gray system GM (1, 1) to predict the supply of Suzhou STIT in 2008-2020.

Assume that $X^{(0)} = \{x^{(0)}(1), x^{(0)}(2), \cdots, x^{(0)}(n)\}$ is a non-negative sequence. Then

$$X^{(1)} = \{x^{(1)}(1), x^{(1)}(2), \cdots, x^{(1)}(n)\} \tag{1}$$

the sequence of 1-AGO generated from $X^{(0)}$, where

$$x^{(1)}(k) = \sum_{i=1}^{k} x^{(0)}(i) \quad k = 1, 2, \cdots, n \cdot$$

$$Z^{(1)} = \{z^{(1)}(1), z^{(1)}(2), \cdots, z^{(1)}(n)\} \tag{2}$$

the sequence mean generated with consecutive neighbors of $X^{(1)}$, where $z^{(1)}(k) = \frac{1}{2}((x^{(1)}(k) + x^{(1)}(k-1)), \quad k = 2, 3, \cdots, n \cdot$ Then

$$x^{(0)}(k) + az^{(1)}(k) = b \tag{3}$$

is called a GM (1,1,) model, where the parameter (-a) and b in the GM (1,1) model are called development coefficient and grey action quantity respectively.

$$\hat{x}^{(1)}(k+1) = \left(x^{(0)}(1) - \frac{b}{a}\right)e^{-ak} + \frac{b}{a}, \quad k = 1, 2, \cdots, n \tag{4}$$

is the time response sequence of GM (1,1).

C. The Supply Prediction Model of Suzhou STIT

The GM (1, 1) is based on data of T&S S, R&D S, T&S S and S&E in large-medium industrial enterprises during 2002 to 2007. The time response sequence of GM(1,1) for T&S S is as formula（5）, the average error is 0.3034％; the time response sequence of GM(1,1) for R&D S is as formula（6）, the average error is 1.2402％; the time response sequence of GM(1,1) for T&S S in large-medium industrial enterprises is as formula（7）, the average error is 1.0177％; the time response sequence of GM(1,1) for S&E S in large-medium industrial enterprises is as formula（8）, the average error is 0.080752％.

$$x(k+1)=734840.870205\exp(0.065936*k)-687982.870205 \tag{5}$$

$$x(k+1)=380147.375223\exp(0.05352*k)-359672.375223 \tag{6}$$

$$x(k+1)=834097.393518\exp(0.056621*k)-787098.393518 \tag{7}$$

$$x(k+1)=503371.365474\exp(0.055282*k)-476188.365747 \tag{8}$$

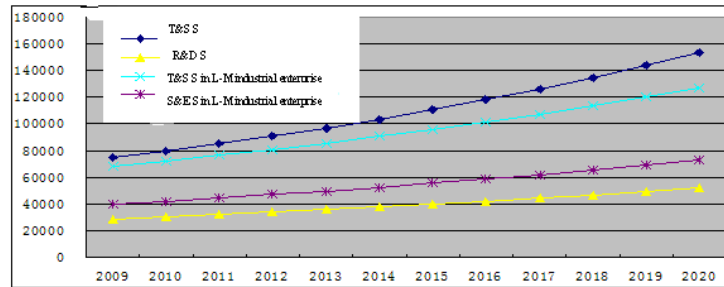## IV. ANALYSIS OF SUPPLY PREDICTION AND SUGGESTIONS FOR SUZHOU STIT

Figure 1. Supply prediction of Suzhou STIT

According to forum (5) ~ (8), the supply prediction of Suzhou STIT during 2008 to 2020 is shown in figure 1, and it's clear that: Suzhou STIT are going to grow with a high speed with Suzhou's social and technological development; the team of T&S S in large-medium industrial enterprises will grow with highest speed, which is closely related to the sturdy basis of Suzhou' industry; the team of S&E S in large-medium industrial enterprises will grow at a lower speed than T&S S; the team of R&D S will remain growth with lowest speed.

From above it's shown that though the job of Suzhou STIT has been ahead in recent years, the dynamical adjustment of STIT structure should be adapt to the development of society and economy. The suggestions for Suzhou STIT are as following:

1) Speeding Up High-Level Talents Introduction.

There are few high schools and research institutions in Suzhou, so it initiates the deficiency of STIT reservation, which leads to absence of scientific and technological leading talents to an extent. In future, Suzhou government should concern the tendency of the world, fully exert its advantages in economy, humanity and geography, and speed up high-level talents introduction At home and abroad. For talents back from overseas, to mainly introduce those owning private intellectual properties and technological innovation achievements; for talents in china, to strengthen the information exchange with famous national high schools and important technological research institutions, establish long-distance interview system between high schools and enterprises step by step and advance the introducing efficiency.

2) Cultivating High-Level Innovation Talents

The roles of multiple channels should be played fully, such as important talents cultivating plans, important scientific research project, important scientific research base, academic exchange and internationally cooperation. The government should actively push forward the team or group building, put more efforts to foster academic leader and key technology staff, and perfect the rules and system of training and select high-level innovation talents.

3) Support More Independent Innovation

As the whole society is not very confident for indigenous local innovation products, so the opportunity is uncertain for them to be chosen in government and enterprise procurement.

Under these circumstances, even if some independent innovations are proven to be a technological breakthrough, enterprise profit are still hard. Therefore, the government should enhance supporting independent innovating products, recommend these products to be list into the export catalog of high-new technology products, invest more in introducing technology and equipments, and encourage re-innovation enterprises export by using the economical instruments such as taxation and exchange rate.

4) Perfecting Motivation Mechanism For STIT

Although the team of Suzhou STIT is large, the overall level is not high enough for enterprises demand. In many enterprises, there is lack of effective mechanism on the selecting, training and motivating innovation talents. Besides, most innovation talents in university stay far from marketing, and their evaluation orientation emphasis on academic papers, government founded projects and awards, neglecting social benefits and practical application. Therefore it's needed to perfect the evaluation and motivation mechanism fundamentally, promote management and technology participating in distribution, and establish income distribution and social security mechanism suitable for the market.

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