

A SOFTWARE BOOM LEADING TO A SHORTAGES OF SKILLED WORKERS IN NANJING

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Introduction

China has undergone a transition from a traditional command economy to a market economy after Mao's death in 1978. The current economy becomes increasingly globalized, with an important role for a few global cities, such as Nanjing (Van Dijk, 2005b). However, there seems to be a human resources paradox in Nanjing. On the one hand the city produces the highest number of skilled workers, on the other hand software companies complain about the shortage of skilled workers for employment in Nanjing's information technology (IT) sector.

The rapid expansion of the Information and Communication Technology (ICT) industry in China, which began in the 1990s, has had very positive effects on the Chinese economy. In fact, during the last decade, the Chinese ICT industry has grown into one of the more competitive sectors. Nanjing, the capital city of Jiangsu province with more than 6 million inhabitants, has been mounting a strong ICT cluster push. ICT activities are mainly concentrated in five districts. Previously we have studied a cluster of ICT companies located in Zhujiang Road in the inner city of Nanjing. In Nanjing we mainly studied IT industries, so we will leave out the communication activities. On Zhujiang Road there are lots of shops and workshops that are mainly selling computers and providing related services are concentrated (Wang 2000, Wang and Van Dijk 2004). The inner city cluster turned out not to be innovative (Van Dijk 2003a), while we found that a dynamic software sector was springing up in two government initiated software parks: the Nanjing Software Park and Jiangsu (Province) Software Park. This triggered us to do the research on which this contribution is based.

In this paper we first review the development of the software sector in China. Subsequently we try to determine IT Human resources management: what kind of talent is needed and what determines whether they come to Nanjing? Based on our surveys we then provide an analysis of IT human resources in Nanjing's software sector and try to identify the factors determining the current paradox.

Software development in China

Globalization suggests that the location and ownership of production becomes geographically dispersed. However, economic forces are stimulating a more pronounced geographical concentration, within particular countries, regions and cities (Dunning, 1998). Firms are drawn to these locations because proximity generates positive effects. The IT and software clusters show a very diverse composition depending on the policy context, the initial size and structure of the cluster, the degree to which local knowledge-resources are exploited, the

¹ Research undertaken with Wang Quansheng, Associate professor in the field of e-commerce at the Nanjing University Business School, P.R.China. e-mail: wangqs@nju.edu.cn, who contributed pages 7-9 below, on What does local labor market provide?

structure and quality of the local and international demand for IT products and services, and very importantly, the quality of the urban living environment.

The Chinese government is really trying to develop a software sector in China and in particular in Beijing, Shanghai and Nanjing. At the moment Nanjing counts 400 software companies, half of the total number in Jiangsu Province (data from local government Nanjing). The Mayor of Nanjing during a speech in 2004 mentioned the figure of 400 enterprises. This would be 40 percent of Bangalore's total (Van Dijk, 2003b). At the national level the city comes at the third place after Beijing and Shanghai. The number of employees in the sector is estimated to be 13,000 (Nanjing only, data from Nanjing municipal statistics bureau website). Together these companies generated a turnover of 57 billion RMB in 2002. This represents an increase of 45 percent compared with 2001. This growth can be explained by the promotion policy of the different levels of government and the opening of three software parks, which started in 2001, 2002 and 2003 respectively. Even more remarkable is the total export of software. For Nanjing alone this amounted for software 16.58 million US\$ in 2002 (Nanjing Municipal Statistics Bureau website)!

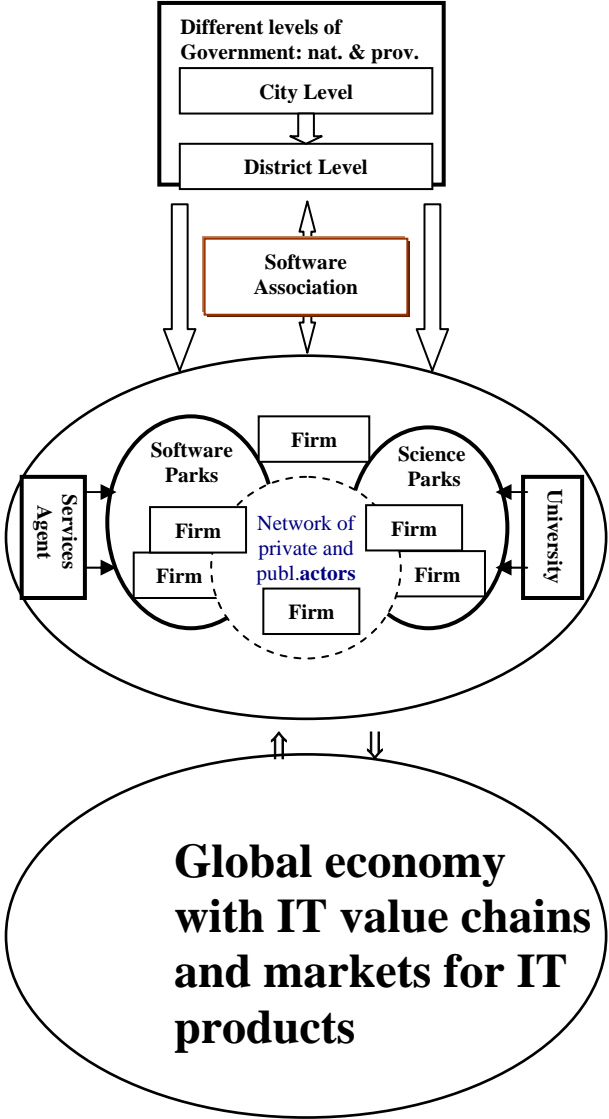
As an illustration of the efforts to promote the software sector the visit of the Chinese prime minister to Bangalore, the Indian capital of software, can be mentioned (Van Dijk, 2003b). He said China wanted to learn from India in the field of software but the Prime Minister very much scared the Indians. However the information technology sector in China itself is also very active and announced recently that they are trying to establish joint software standards with Taiwan, to promote exports (China Daily, 9-9-2003). At the same time a 'war on software piracy' is announced. The copyright administrations in different provinces have started special actions against pirated software. The National Copyright Administration launched it as a move to support the development of China's own software and electronic industries.

The development of IT activities, including software production is put in a global value chain context and the key actors at the local level are named. Global companies play a pivotal role in the way local innovative networks relate to global networks. The conceptual framework is depicted in map 1.

Knowledge flows are facilitated by personal relationships and mobility of employees, or through spin-offs from larger firms. Hall (1998) stresses the special advantage of (some) urban regions for IT activity. He points at the fruitful marriages between IT and typically urban sectors such as cultural and entertainment industries. Cities with particularly good prospects are those with a thriving cultural life, a rich history, and high quality of life. Finally, Porter (1998) stresses the importance of large and critical local demand as a condition for cluster development and a trigger for innovations. This demand may be important for IT clusters as well: there is some evidence that IT-firms tend to locate near their main customers, in regions with high concentrations of financial and business services (Roost, 1998).

Besides the software companies the actors are the local governments, the Nanjing Software Industries Association (set up by the local government in particular the Nanjing Municipal Software Development Office, which is part of the Nanjing Municipal Science and Technology Bureau), service agents (the business support system) and universities and research institutes. The nature of their interaction is very much the topic of this research.

From the various visits to industrial estates and bureaus we have constructed the following table showing of the importance of the Software sector in Nanjing.

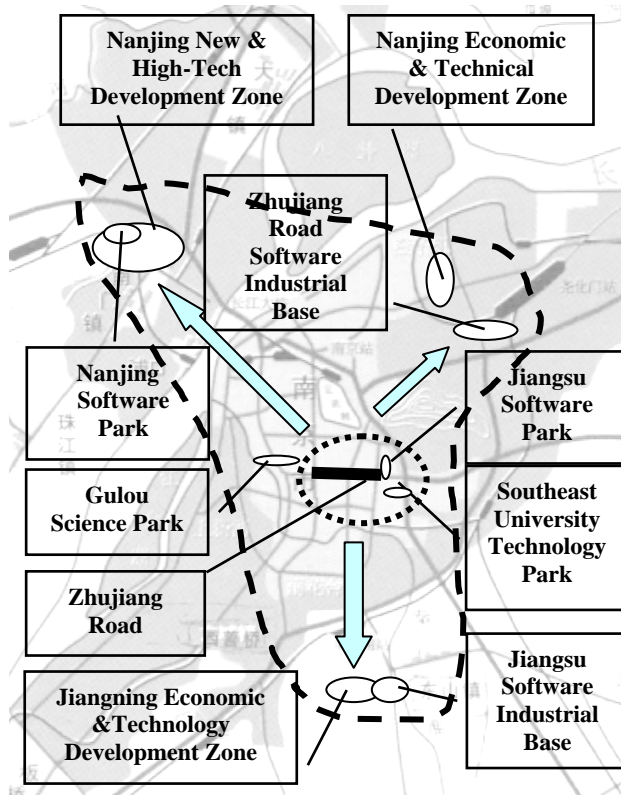


Map 1 Governance of IT cluster and its interaction with the global economy

For the IT sector the following five districts are in particular important, because IT activities are concentrated in those districts (see the map 2):

- Xuanwu District with an IT cluster (defined as a strong spatial clustering of IT activities) on Zhujiang Road in the center of the city and the location of the Jiangsu Province Software Park (JSP) and Southeast University Science and Technology Park;
- Gulou District with the Nanjing University-Gulou District nationally approved University Science and Technology Park in the western part, extending to the north west until the river;
- Jiangning District in the south, where the Jiangning High Tech Industry Development Zone is located;
- Xixia District in the north east, where the Nanjing High Tech Development Zone is located;

Pukou District, in the north west of Nanjing, where the High Tech Development Zone is developed, and where the so-called Nanjing Software Park (NSP) is located.



Map 2 Location of Nanjing IT Clusters (Based on Wang in Wang and Van Dijk, 2004)

The Institute of Software at Nanjing University was founded in April 2002 and is located in the High Tech Development Zone, near to the Nanjing Software Park and the Pukou campus of Nanjing University. It is one of the engineering schools in the university and developed a curriculum covering the edge of the software technology and meeting the demands of industry. It counts 150 undergraduates and 82 graduate students. The numbers will gradually be increased to 1500.

All software parks face space problems and envisage a distinction between a limited number of the smaller companies in the center of town and a software industry base further away. Their importance is quantified in table 1:

- a. Gulou along the river in the north west of the city
- b. The South East University Science and Technology Park (SEU) of the Xuanwu District in the north east near the new campus park, where four universities are located
- c. The Jinagsu Province Software Park JPSWP in the southern district (2 and eventually 6 km²)
- d. The Zhujiang Road larger area

It seems they are examples of uncoordinated activities of local governments, which points to the absence of intervention or coordination by higher levels of government, when the implementation of economic policies is left to the lowest level of government. This also suggests some de facto decentralization of economic policies in China, which tends to be beneficial for urban development (Van Dijk, 2000).

Development zones have become important and overseas funds invested in these development zones accounted for 65.8 percent of Jiangsu province's total contracted overseas funding (China Daily, 16-5-2001). However, the conviction is growing that the market and not the government should develop technology parks (China Daily, 27-3-2002). Government's support, especially favorable land transferring policies is considered essential, but "only the market can test and improve their operations".

Table 1 Location and number of software companies in Nanjing

Districts	Location	Parks in district	Number of IT companies
Xuanwu	Center	Jiangsu Province Software Park South East University Science Park Zhujiang Road Software Park	JPSP 171 software companies SEU SP 110 IT companies, 30% of them are software companies, or about 33 Some 1500 small IT companies mainly concentrating on computer selling, of which around 30 software companies
Gulou	Western	Nanjing University-Gulou District University Science and Technology Park	160 companies in S&T Park, of which some 20 real software companies
Jiangning	South	Jiangning Development Zone	Around 10 IT companies related with hardware manufacturing
Xixia	Northeast	Nanjing Economic and Technical development Zone	Around 10 IT companies related with hardware manufacturing
Pukou	Northwest	Nanjing High Tech Development Zone and Nanjing software Park	160 software companies
Total	number of	Software companies: IT companies:	Almost 400 software companies Some 2000 IT companies

However, the different Parks also compete with each other. Who attracts the most promising IT company? In the following chapter we will come back to the factors that played a role for the software companies to choose a location in Nanjing. From the evidence so far the available infrastructure, the distance from the city center and the type of companies one finds in the different parks are factors that could play a role. On top of that the service level is different. Some of the Parks have incubator services, others don't, some have serious relations with universities, some don't and finally the physical location is important where the south of the city is close to the airport and the road to Nanjing, while the northern part is a cross the river, and far away from the city center and the airport and highroads to Shanghai.

IT Human resources management

What are the characteristics of IT talents and which factors determine whether such talent is available in Nanjing? Important factors are salaries and secondary work conditions, the culture of the company and the possibilities to make a career. The human resources paradox in Nanjing is that on the one hand the city produces the highest number of skilled workers, on the other hand software companies complain about the shortage of skilled workers for employment in Nanjing's information technology (IT) sector. We conclude that it is necessary to put the kind of qualifications required in the emerging software sector versus the skill profile of the S&T workers and the students turned out by the system of higher education in Jiangsu province.

The analysis of IT human resources in Nanjing's software sector

High skilled workers for the software industry are difficult to find, more than 80% companies in our study of software producers mentioned that high-skilled labor force or managers are in short supply (see Table 2). This leads us to formulate the human resources paradox: are there shortages of skilled workers for Nanjing's IT sector despite the enormous research and education infrastructure in Nanjing?

Employment in the enterprises interviewed usually increased a lot (44%) or somewhat (44%) during the last year. Only four enterprises said that employment remained stable and two that it declined somewhat. 44 percent of the interviewed software managers mention that the number of people leaving has increased somewhat. The other software producers (36%) note no change or even a small decrease in the number of people leaving (16%).

Although the problem is similar to what was found earlier on Zhujiang Road (Wang, 2000), the software producers are seeking solutions by suggesting organizing training courses and by indicating that they like linking up more with the universities and training institutes of Nanjing. The most important factors to be improved are better living conditions (improved housing and infrastructure) and more urban amenities, in the field of sports and culture (see Table 3).

Table 2 Attitudes about Labor Market of Software in Nanjing

		Count	Percentage
Low-Skilled Labor Force	Enough	49	98.0%
	Slightly Shortness	1	2.0%
	Enough	1	2.0%
High-Skilled Labor Force	Slightly Shortness	5	10.0%
	Shortness	34	68.0%
	Very Shortness	9	18.0%
	Critical Shortness	1	2.0%
	Enough	3	6.0%
High-Quality Managers	Slightly Shortness	4	8.0%
	Shortness	14	28.0%
	Very Shortness	19	38.0%
	Critical Shortness	10	20.0%
	Enough	3	6.0%

Table 3 Factors Should Be Improved To Attract High-Skilled Labor (Among 45 Cases, 5-N/A)

	Salary		Living Environment(Housing & Infrastructure)		Transportation		Urban Amenities(Culture & Sports)	
	Count	Percentage	Count	Percentage	Count	Percentage	Count	Percentage
Don't Need	4	8.9%	6	13.3%	4	8.9%	3	6.7%
Need A Little	11	24.4%	16	35.6%	14	31.1%	10	22.2%
Need	16	35.6%	16	35.6%	19	42.2%	14	31.1%
Strong Need	11	24.4%	6	13.3%	7	15.6%	12	26.7%
Critical Need	3	6.7%	1	2.2%	1	2.2%	6	13.3%
Total	45	100.0%	45	100%	45	100.0%	45	100.0%

According to earlier research access to skilled labor and a low tax burden were also mentioned as important location factors for Nanjing (Van Dijk and Wang 2004). At the same time the entrepreneurs interviewed complain that finding skilled people in Nanjing is a problem. The table below gives the macro picture of the problem by summarizing the expenditure on and number of employees in the S&T sector in Nanjing and its competitors: Beijing and Shanghai. It turns out that the Jiangsu Province is first in number of S&T institutes and first in the number of S&T personnel. It is third concerning the sources of funds for S&T and the expenditure of learning, but in the first case ahead of a much bigger city as Shanghai. The question remains

why, if so many S&T institutes can be found in the province and so many S&T workers are employed there, would there be a shortage?

Table 4 Expenditure on and number of employees in the S&T

Variable	Beijing	Nanjing/Jiangsu Province	Shanghai	Total
Number of S&T institutes	57 (19th)	293 (first)	62 (16th)	2930
S&T personnel	257326 (3th)	328585 (first)	178875 (6th)	3221822
Sources of funds for S&T Total*	4452878 (first)	3024794 (3th)	2783230 (fourth)	29379898
Expenditure for higher learning*	307211 (first)	206659 (3th)	212783 (second)	2041666

Source: China Statistical Yearbook on Science and Technology 2003

* in 10,000 yuan

What do the software companies need? They need of people with “Multiple Talents”, who acquire a diverse and relatively rare “package” of skills including appropriate technical skills and complex non-technical skills including:

1. Business Acumen — building/managing budgets, business process analysis, marketing and finance principles, and contractor/vendor management;
2. Communication Skills— teamwork, relationship-building, communications of many types and purposes;
3. Organizational Skills — working effectively across organizational/ functional boundaries, gaining needed/scarcely resources;
4. Project Management — planning, coordinating and delivering on time, budget and within specifications;
5. Leadership — strategic thinking, providing goals and direction, motivating others.

Firms want candidates with certain, relatively intangible, personal characteristics (traits, attitudes, values, etc.) to fit their culture and expectations, such as, creativity, ambition; strong work ethic and quick learner. They also want “loyalty” on the part of both employees and employers are no longer a reasonable expectation. On the contrary, employees with value in the labor market are expected to leave within a few years of employment, and firms are expected to dismiss any employee at anytime.

Given a reasonable compensation package, financial factors are not considered to be the primary incentive for valued individuals to join a firm, develop their skills or stay put. Firms must provide a combination of incentives that suit a candidate’s needs, interests and expectations.

What does local labor market provide?

Table 5 provides an overview of the wage levels and the characteristics of the labor pool for main regions which focus on software development. As the table shows there are considerable differences in wage levels, Salaries for software workers in China vary significantly, depending on location, technical skills level, English or other language skills, management experience, etc. The figures for wages for software workers are from 2000 and show that the cheapest locations are Xi’an, Dalian, and Nanjing. What this table reveals is that senior managers are most expensive in Shanghai, followed by Beijing and Guangzhou. For software

workers Dalian, Xi'an and Nanjing is much cheaper than Beijing and Shanghai. The cities with most relevant universities are Beijing Shanghai and Nanjing. The most skilled work force, measured by the percentage of people working in the software industry with an education level of at least a master's degree is found in the regions of Guangdong, Beijing, Jiangsu and Shanxi.

Table 5 Labor Cost and labor Pool Characteristics

Province	Beijing	Shanghai	Guangdong	Liaoning	Jiangsu	Zhejiang	Shanxi
City	Beijing	Shanghai	Guangzhou	Dalian	Nanjing	Hangzhou	Xi'an
HR cost	Salary top Manager	49,362- N/A	57,646- 46,888	44,043- N/A	N/A	N/A	N/A
	Salary mid manager	25,812- 24,750	25,232- 20,523	23,869- 19,460	N/A	N/A	N/A
	Wages Software workers USD	6,011	5,773	5,675	2,733	3,514	4,378
Labor pool	No. of developer	49,000	23,000	56,000	11,000	9,000	18,000
	% Software staff with above MSC education level	14%	9%	16%	4%	11%	7%

Source: ChinaHR.Com (2000), CSIA(2003).

It turns out that the Jiangsu Province is first in number of S&T institutes and first in the number of S&T personnel. It is third concerning the sources of funds for S&T and the expenditure of learning, but in the first case ahead of a much bigger city as Shanghai. The question remains why, if so many S&T institutes can be found in the province and so many S&T workers are employed there, would there be a shortage?

In order to satisfy the process of software development, the ideal structure of workforce is a pyramid-shaped skills structure with the following three skills levels:

1. High-level Skills, Management, Analysis and Design Skills

Sources: graduates from universities and research institutes with work experience, returning graduates from overseas, foreign talent

2. Mid-level skills, Backbone Software Development Skills

Sources: non academic training organizations, inexperienced with work experience, returning job training.

3. Low-level skills, Technology Workers

Sources: specialized technical secondary schools and training centers. This type of training is intended to have a very practical orientation.

However, the real composition differs drastically from the ideal picture. As of today this skills structure has the shape of an olive with too many people with mid-level skills and too little people with high-level managerial skills and low cost software workers.

Table 6 Software Labor Education and development level

Province		Beijing	Shanghai	Guangdong	Liaoning	Jiangsu	Zhejiang	Shanxi
City		Beijing	Shanghai	Guangzhou	Dalian	Nanjing	Hangzhou	Xi'an
Education	No of Universities with software rel. courses ("Model SW-School)	10 (7)	6 (4)	3 (3)	1 (1)	6 (2)	2 (2)	3 (3)
	Science and engineering universities	18	12	4	6	17	18	8
	Comprehensive Universities	5	2	15	1	4	8	2
	Technical secondary school (engineering)	25	37	53	46	65	31	27

Source: China Statistical Yearbook (1994-2003) and CSIA(2003).

Table 4 provides an overview of the current software education situation as well as some data on the general development level in China's regions. The first column signifies how many universities each city has that provides education relating to computer science and software engineering, the number in clauses is the number of "model schools" that the government has set up as models to reform software related education. There are also figures on the overall number of universities. In that context, comprehensive universities simply mean universities that provide a number of fields that can include engineering as well. Most of these regions have quite a number of universities. The reason for including technical secondary schools is that this is one of the future sources for "blue collar" software workers.

However, there are a number of problems related to traditional computer science education in China (CSIA 2003):

1. There is a gap between software training and real practice
The training provided at universities has traditionally not been very well adjusted to the market's demands. Emphasis has been put on theory, which means that graduates from related disciplines rarely have practical experience or knowledge of international standards.
2. Teaching material has not stayed up to date with the pace of change in the IT industry.
The use of outdated teaching material and strong emphasis on theory has forced the companies that want to hire a fresh graduate to train him for 6-12 months before he can be put to work.
3. The workload at the universities has been too high.
This limits the students' spare time and opportunities to develop on their own.
4. There is a lack of differentiation and suitable structure.
Teaching material and methods are also more or less the same in all universities around the country. There is little differentiation between the different universities and little differentiation in teaching suitable for fostering different work roles (CSIA 2003)

In the current structure of workforce, the dominant group is students with Bachelor's degrees in Computer Science. The high dependence on higher education makes it difficult to expand the workforce rapidly and to standardize work roles. The BA graduates that carry out most of the work today are badly suited for high-level management or design roles due to their lack of experience. On the other hand, they are overqualified and cost too much for simple coding.

Now skill shortages are a critical issue in the local software labor market. The software industry, in particular, is dependent on human capital to a degree that significantly exceeds that of many other industries. In the software industry, the supply of human capital is so critical that the availability of skilled workers is an important factor in location decisions. The difficulty with skill shortages, however, is that they cannot be observed or measured directly. What is observed is adaptive behavior, employers' reported difficulties in recruitment and retention in this case.

Another problem that faces the Nanjing software industry is that the best students tend to go to multinationals or overseas for further studies or the bigger cities. Even though higher education system produces quite a reasonable number of skilled software talents, but most of them leaves Nanjing. In a survey carried out by CSDN, China's largest developers' community, software developers were asked to vote for where they would like to work (CSDN, 2004). The result highlights the fact that one is most likely to find highly skilled software developers in the three major cities: Beijing, Shanghai and Guangzhou.

Conclusions

The Science and Software Parks are clear examples of government led urban development. They are usually the result of a joint effort of different layers of government. They have managed to make it attractive for the IT companies to come. However, the interviews confirm that life is much easier for a bigger company with good relations with the authorities and this may explain the frustration of some of the smaller IT companies, who don't have such a preferential treatment.

It points to the difference in policies for the big ones and the smaller companies. In fact the local governments seem to go for the big ones! After all 20 percent of the companies contribute 80 percent of the government's income. Local governments also argue that the big ones pay the taxes allowing local governments to do something for the smaller ones.

China's information and communication technology industry has become the third largest in the world and a major income earner (China Daily, 27-9-2002). However, the same article stresses that China should change its image as a low-end manufacturer by increasing the technology content and controlling the patents of high-tech products. Development zones have become important and overseas funds invested in these development zones accounted for 65.8 percent of Jiangsu province's total contracted overseas funding (China Daily, 16-5-2001). In Nanjing there are several high tech zones and the linkages between these zones and the inner city network that we studied could be developed further, to turn the whole ICT sector in Nanjing into a real citywide dynamic high tech cluster. Suggestions for the relevant policies at different levels of government can be made, but in Nanjing we mainly studied IT industries, so we will leave out the communication activities.

The recent development of software activities in Nanjing has been extremely fast. We can no longer say that Nanjing is mainly a hardware-producing city, with a large number of outlets for computers and computer related activities at Zhujiang Road. The role of different layers of government in speeding up this growth process has been important and not been reported on empirically earlier. The other reasons for the rapid development of the software sector are the success so far of two of the three software parks and the co-operation between software producers in practice and through their Nanjing Software Industry Association.

Concerning the software sector, one notes once again that the Chinese government has a clear strategy and puts in place the resources necessary to implement it. The mayor recently mentioned she expects Nanjing to count 1000 software companies by 2010! The government certainly wants this software cluster in Nanjing to take off and thinks about a citywide cluster and not just an inner city cluster. This requires some co-ordination between the different levels of government concerned, which was sometimes missing in the past. A strategic plan to develop the software cluster in Nanjing should be developed at the municipal level and be implemented with the concerned districts solving also the labor shortage issue.

The software producers of Nanjing are not only integrating in a local value added chain they are also becoming more and more part of a global value added chain. The relationship goes in two directions. In the first place through the supply chain and secondly because the world starts buying these software products. The software producers buy in the global market the more sophisticated equipment they need and advanced software that is not produced in China. They offer their software, either as part of joint projects, or tailor-made for a customer. Contrary to India (Van Dijk, 2003b) a number of own products with trademarks start to develop. These may eventually also be able to conquer a place in the world market under their own trademarks. We refer in particular to the security, power and telecommunication related software. It is, however, much more difficult for the smaller software enterprises to develop and market their own trademarks in China and in particular abroad. A community of software producers has developed in Nanjing as a new governance structure and is negotiating with the local government to create the right environment for the further development of the cluster.

The solution will be sought in the kind of qualifications required in the emerging software sector versus the skill profile of the S&T workers and the students turned out by the system of higher education in Jiangsu province. What can be done to get a better match and to make Nanjing more attractive for the high skilled workers needed in its emerging software sector? The local government has formulated policies and provides incentives to skilled IT specialists to return to Nanjing. It will also be necessary to formulate local IT training based on an integration of the activities of universities, vocational schools and training organizations. At the firm level the main factors turned out to be salary, training, corporation culture and career perspectives. This is in particular important if Nanjing wants to continue its role of becoming a global city with an important IT sector (Van Dijk, 2005b).

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