XXV IASP World Conference 2008

Research on Innovation Cluster Indicators of the Hsinchu Science Park

Plenary Session 5:

Impact measures for STPs

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Executive Summary:
This paper specifically creates a set of innovation cluster indicators for the Hsinchu Science Park and shows how they relate to the development of nearby regions and related industries. It aims to provide a conceptual framework for explaining the cluster's competitiveness (or competive advantages). This paper analyzes the arising of industrial clustering effects based on a framework of innovation formed of four factors : economy, innovation, talent and environment, from which Hsinchu City receives the most significant impact, followed by Hsinchu County.

Keyword: Innovation Cluster, Competitiveness, Evaluation

I. Introduction

Industrial cluster analysis relies on a broader sense of competitiveness analysis for evaluation of industrial performance. The encompassingly integrated indicators advantageously enable an analyst to explore the future outlook of an industry, other than appraising its past performance. Rather than confining the studied objects to individual enterprises, the cluster analysis encourages policy makers as well as scholars to take into account a regional or national economy from the perspective of clusters formed of relevant enterprises and supporting infrastructure. It therefore requires a new analysis framework for government, enterprises and other decision makers to fully realize how the clustering process has positively facilitated the development of many enterprises at relatively low cost. As a result, the past decade has seen much effort on the research of industrial policies focused on industrial cluster development.

This paper specifically creates a set of innovation cluster indicators for the Hsinchu Science Park (HSP)and shows how they relate to the development of nearby regions and related industries. It aims to provide a conceptual framework for explaining the cluster's competitiveness (or competive advantages). Comparsions are also made with other regions (or science parks) in Taiwan.

Since 1997, we have been doing a series of statistical researches on the economic infrastructure of a wider range of HSP-influenced regions. The adopted methodology emphasizes strict accuracy and all indicators have been verified for their statistical significance, with each variable's contribution assessed using statistical method.

The analysis focuses on providing practical results based on easily accessible data and commonly used analysis methods, although either being far from perfection. The challenge lies in trying to derive satisfactory causal relation with limited amount of time series data. However, even it is unlikely to obtain meaningful results from tests based on our derived causal relation model, understanding the correlation between the economies of HSP and its neighboring regions is of more vital importance. Despite numerous challenges encountered in the process of statistical analysis, this year's reports will be all the more robust and convincing.

Our research goal is to develop a set of HSP innovation cluster indicators for measuring, and hopefully being useful in the enhancement of, HSP's competitiveness. This project will, after comprehensive theoretical and empirical research, build a set of innovation cluster indicators which take into references such cluster indicators as the annually updated Silicon Valley Index, the Index of Massachusetts Innovation Economy and the index proposed by the National Tsing Hwa University based on "Development of HSP innovation cluster indicators" published in 2006. Our set of indicators also takes into account Taiwan's economic and social environment.

Industrial cluster analysis is fundamental to industrial decision-making. Besides providing tools for analyzing innovation systems, industrial cluster analysis serves as a tool for cultivation and growth of national strategic industries through furnishing guidelines for the development of innovation systems.

Cluster analysis provides a forum for constructive enterprise-government dialogue. It not only discerns common problems, but also identifies common development opportunities, as well as public and private investment opportunities.

This project is divided into six parts, with the first part being this introduction. Section 2 briefly reviews industrial clustering theories, covering topics of competitive advantages of industrial clusters, industrial clusters and competitiveness enhancement for regional industries, and innovation industrial clusters, with emphasis placed on the exploration of high-tech industrial clusters and their impacts; Section 3 addresses methodology for science park evaluation, with a view to developing an indicator systems focused on science parks. It covers evaluation systems, comprehensive evaluation of the science park, topic-based evaluation and development evaluation; Section 4 focuses on the HSP innovation cluster's main indicators, including the development of the HSP industrial clusters, the Silicon Valley Index, the Index of Massachusetts Innovation Economy, and the required indicators for HSP; Section 5 describes the 2007 HSP Innovation Cluster Indicators, which are further analyzed in detail under categories of economy, innovation, talent and environment; Section 6 concludes the research and makes recommendations, giving outlined meanings of each indicator, suggestions and direction for future research.

II. Innovation Clusters

In a global economy nowadays, an enterprise can only achieve high return through long-term competitive advantage secured by constant innovation to generate high efficiency that is particularly essential to high-tech industrial clusters. This is evidenced by the supporing data of a study on the Silicon Valley's semiconductor industry. Saxenian (1981) divided the semiconductor industry's processes into three phases (or categories), namely research and development phase, manufacturing phase and assembly phase. The research and development phase involves in itself a series of direct technological innovation activities. The manufacturing phase contains relatively less amount of innovation activities while the assembly phase encompasses the least amount of innovation activities. Studies show that most of the research and development processes which encompass the highest amount of innovation are carried out in the vicinity of the Silicon Valley (up to 79%). The manufacturing processes which have less amount of innovation activities are mostly done outside the Silicon Valley - mainly distributed in the United States, Europe and Japan (with Silicon Valley accounting for only 36%). The assembly processes with the least amount of innovation contents are almost not conducted in the Silicon Valley, which accouts for a mere 3%, with the majority part (88%) distributed in the third world countries. Obviously, other than factors like labor cost, the research and development processes center around the Silicon Valley mainly for the innovation advantage it brings forth. The innovation advantage is a major source of benefits for industrial clusters, especially for high-tech industries which rely on fast-paced technology advancement.

An innovation industrial cluster facilitates its member enterprises to easily acquire technology knowhow and market information, to establish a platform for joint research, development, production and selling activities with external business world, and to maintain good linkage with suppliers and customers. It essentially ensures smooth proceeding of research and development, design and prototyping, creation of art of manufacturing, and production and selling.

2.1 Regional features of innovation

Four aspects determine the features of a technology innovation: 1. the development stage where the current technology resides. Technology development usually follows a spiraling path, starting with a breakthrough that pushes the technology into a new stage (in one sense, a new technology paradigm), followed by a mass of progressive innovations that gradually unleash all underlying efficiencies of the technology model until a stage of technology stability is reached on which a new cycle may begin. In all stages, innovations vary significantly in the difficulties and features involved; 2. the difficulty and manner of innovation diffusion; 3. the serial correlation between innovation activities. This is the degree of dependence on the results and experiences from prior researches. An innovation that depends on personal experiences tends to show higher serial correlation as it is susceptible to non-systemized knowledge. An innovation staged at the beginning of technology development will be low in its serial correlation as less knowledge is prerequisite; and 4. the knowledge base, which includes the body, property and the means of creation and dissemination, of the knowledge required by the innovation activities.

2.2 Formation of industrial innovation clusters

It is generally believed that people of all regions have the potential to innovate but it is also true that innovation potential gets fully developed only in an environment rich in innovation resources, efficient in fascilating innovation systems and highly repaying in innovation return. An industrial innovation cluster provides an environment with all ingredients required for good innovation.

The main ingredients in forming an industrial innovation cluster include the knowledge center, entrepreneurs and innovators, core industries, local governments and supporting environment. The knowledge center provides the fundamental for an industrial cluster's long-term development. Appropriate innovation environment ensures smooth technology innovation. Industrial development lays the ground for innovation to be commercialized for economic benefits. Entrepreneurs and innovators play the role of organizing for and implementing innovation. The local government is the central part of institutional innovation that includes creation of a supportive policy systems and innovation systems.

III. Methodology for Science Park Evaluation

The rationality of evaluation has long been a concerned problem in the fields of philosophy of science, theory of economics and management theory. Despite variations on the understanding and viewpoints of the rationality issue, people acknowledge the existence and complexity of the problem. In the transformation from general to specific scope, the science park evaluation issue inevitably has to deal with the problem of rationality which can be described in nine key aspects:

1. Rationality explained

The rationality indicates high degree of recognition as the evaluation has been conducted on experiential and theoretical basis. An evaluation needs to follow scientific principles, with observables (in the form of data or information) obtained and analyzed scientifically, transparently and in a repeatable manner. The rationality of evaluation therefore implies being scientific. An unscientific evaluation inevitably comes out with poorly recognized results and, of course, little rationality. But, due to subjectivity involved in evaluation, it is unlikely that an evaluation can produce results recognized by all people and rationality is therefore of only relative significance.

2. Criteria for rationality

There are absolute and relative criteria for rationality. The absolute criteria include consistency in the experiential and theoretical basis of evaluation and recognition, authenticity of observables and logics of inference. The absolute criteria are mainly used for discerning a single-result evaluation while the relative criteria are used for comparing multiple evaluations on the same objects.

3. Objectives of evaluation

The science park evaluation has three objectives: to derive rules for science parks development in academic aspect, to summarize the operation performances and development variations for science parks in management aspect, and to uncover problems along with science park development in the aspect of decision making. The actual evaluation deals with three non-distinctive aspects mingled together, differed only by their emphasis. The theoretical, management and decision aspects in evaluation exactly correspond to the development processes from theory to implementation. Objectives are the driving forces for and the basic values of evaluation.

4. Selection of evaluation indicators

The development and attributes of a science park is an indivisible whole object of evaluation. But due to the limitation of perception, they have to be mentally decomposed into multiple units with each being a "perception unit" represented by an evaluation indicator. The whole assessed object is then approximated by a representative composite indicator system. Obviously, this is merely an abstract approximation instead of a factual equation. The composite indicator system can be made to more closely approximate actuality with more evaluation indicators, at higher cost of evaluation of course. Lower cost of evaluation can only generate smaller composite indicator system which produces results far deviated from actuality.

5. Qualitative versus quantitative indicators

Of the science park development and attributes to be assessed, some are beyond quantitative description. Examples of these types of attributes include cultural development and environmental protection, for which qualitative indicators have to be used. A typical qualitative indicator graded as outstanding, good, fair and unqualified can usually be semi-quantitatively represented by the numbers 1, 2, 3 and 4, respectively. Quantitative indicators should be carefully selected in terms of the people's recognition and their trueness, namely reliability and validity. To increase the objectivity of the outcome, selection of evaluation indicators should emphasize much more on quantitative than qualitative features.

6. Impact of indicator's measurement unit and scope

In comparing multiple science parks, the "unit" adopted for an evaluation indicator has significant impact on the measured value of the indicator. For example, changing the patent measurement scope from "patent application" to "patent approved" causes major changes in the measurement outcome, despite no substantial differences being created in the measured targets. Moreover, some indicators generate outcomes with much different meanings when measured in absolute versus relative manners. For example, the indicator "scientific & techical employees" measured in absolute numbers differs from that measured in terms of the "scientific and technical employees as the ratio of the whole company's employees", which has significant impact on the evaluation results.

7. Subjective judgements in evaluation

Four subjective judgements exist in the evaluation of the science parks: (1) selection of evaluation indicators; (2) determination of each indicator's measurement criteria; (3) assigning to each qualitative indicator a "fuzzy" score (such as "stronger", "strong", "fair" and "weak"); and (4) weighting of each indicator. Subjective judgements are inevitable in any evaluation while objective evaluation is an ideal case. An evaluation system can only be evaluated by its results in the sense of satisfaction or recognition.

8. Differentiated evaluation among multiple systems

Evaluation of the same science park based on different perspectives and interests usually come out with varying results, which is significant more specifically in the ranking of companies considering the company's R&D technology and the company's being headquarter, branch or factory. Compared to most of the objectively selected evaluation indicators that have win common recognition among different evaluation systems, the subjectively determined weights for these indicators are the major causes of varied evaluation outcome. Therefore, multipl evaluation systems can negotiate to reach a consensus on these weights in order to balance among the differentiated evaluations.

9. Operation status of the assessed objects

In the management of science parks, the government always has to deal with a need for comparing the operation status among multiple science parks at a specific time horizon, for comparing the development level of a specific science park at different time horizons, and for comparing the development level of multiple science parks at different time horizons. It is obvious that dynamicity and time comparability should be taken into account in the determination of the indicators' weighing coefficients at different time horizon.

IV. Construction of HSP's Innovation Cluster Indicators

4.1 Development of HSP's Industrial Clusters

The HSP's industrial clusters have been developing in three phases: the PC-oriented phase in 1980s; the IC-oriented phase in 1990s and the innovation-oriented phase in 2000s. Currently the IC industry and optoelectronics industry are among the best developed industries with remarkable success in terms of scale.

As of the end of June, 2007, HSP has established for its IC industries a supporting system based on professional division of labor that includes 128 IC design companies, five wafer materials vendors, five mask producers, 17 wafer fabrication companies, 11 packaging companies, three testing companies, three lead frame manufacturers, six silicon wafer suppliers, five test equipment suppliers, 17 process equipment and tools suppliers, five EDA companies and one liquid nitrogen supplier. The scale and completeness of such a well formed peripheral supporting system is nowhere else seen other than in the United States and Japan. Small but highly entrepreneuric, most companies have achieved remarkable development by focusing their limited resources in specialized fields, with a manifested potential of seizing a greater market share.

Taiwan's semiconductor industry, after more over 20 years of development, has formed up a complete world-class team of high-tech industrial players comprised of up-, mid- and down-stream manufacturers, with total output of NT$800 billion in 2003 and NT$1.3933 trillion in 2006. However, it took Taiwan's flat panel display industry only seven years to become a leader in manufacturing and supplying, with 40% of global market share. The total output reached NT$410 billion in 2003 and doubled in 2006, to a level of NT$823.3 billion. Taiwan started in 1992 its production of small-scale (below 10 inches in dimension) TFT-LCD panel. It did not engage in the production of then prevailing high-tech fashion of TFT-LCD panel over 10 inches in dimensioned until 1998. Taiwan's global market share of TFT-LCD panels first caught up with South Korea in 2005 and reached 48.8% in 2007, outperforming South Korea's 37.7%. Currently most South Korea's competitive manufacturers are procuring or seeking help from Taiwan.

Under the coalition of government and participating companies, the TFT industrial cluster has gradually developed into completeness, stretching from Longtan and Hsinchu in the Northern Taiwan, through the Central Taiwan Science Park, all the way to Tainan. The narrow strip of production clusters along the west coast highway including Taoyuan, the Central Taiwan Science Park and Tainan's TFT-LCD industrial cluster park is an indication of Taiwan's gradually formed TFT industrial clustering effect, which will contribute to the industry's overall international competitiveness.

Taiwan's critical status in global TFT-LCD production has attracted world-class upstream key component suppliers to invest in the science parks and industrial zones, forming more closely linked industrial clusters and establishing Taiwan as a major global supplying system for TFT-LCD. The overall domestically supplied components have overtaken imported components and therefore the production cost has dropped significantly. Meanwhile, the on-going momentum of industrial flourishment has spurred the will of domestic equipment acquisition by domestic players.

4.2 Indicators HSP Should Establish

Among the two sets of indicators – the Silicon Valley Index[1] and the Index of the Massachusetts Innovation Economy[2] – those emphasing economic performances and innovation are best candicates for HSP.

These include, take the Silicon Valley Index as an example, 1. Innovation, 2.Employment ,3. Income.

They also should include, from the Index of the Massachusetts Innovation Economy, 1. Industry Cluster Employment and Wages, 2. Corporate Sales, Publicly Traded Companies, 3.Occupations and Wages, 4.Household Income, 5. Manufacturing Exports, 6. New Business Incorporations and Business Incubators, 7. New Business Incorporations and Business Incubators, SBIR, 8. Corporate Research and Development Expenditures, R&D, 9. Patent Grants, Invention Disclosures, and Patent Applications, 10. Technology Licenses and Royalties, 11. Educational Attainment and Engineering Degrees Awarded.

Qi and others (2006)[3], in their study on the development of HSP's innovation cluster indicators, proposed 23 indicators based on the Index of the Massachusetts Innovation Economy. The proposed framework is compresensive with most of proposed indicators focusing on economic and innovative dimensions. However, the study is supported by underestimated industrial data which cover only a short period (two or three years) of time series, resulting in inadequate power of explanation. This study is carried out on the basis of their study and tries to make some corrections.

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1 Silicon Valley Index: http://www.jointventure.org/publicatons/index/2007%20Index/index.html

2 Index of the Massachusetts Innovation Economy: http://www.masstech.org./institute/the_index.htm

3 Qi, Yu-lan, Chun-xing, Huang and Rui-hua, Liu (2006), *Development of Innovation Cluster Indicators for the Hsinchu Science Park*, a research project commissioned by the Science and Industrial Park Administration , March 2006

But what indicators can be used for measuring the competitiveness of a science park? Based on the investigation of Ma, Weiyang (2007 a & b)[4], Many indicators are proposed by science parks and scholars for measuring a science park's competitiveness. To derive a representative and meaningful indicator, a science park's objective, industrial types, number of employees, size and regional characteristics must be taken into account. Our survey shows that many parks and scholars have pointed out that a universal indicator for all science parks does not exist and it is difficult in fact to measure all science parks with one single indicator. As parks vary with regions, meaningful measurement will be possible only among parks with similar unique characteristics. An overall measurement carried on all science parks inevitably will produce distorted outcome.

The emergency of cluster is reflected in the apparent increase in employment, salary and added-value in relation to national or global economy. Although the past studies did not draw consistent conclusions regarding to the effect of different development factors on economical development, however, through the establishment of suitable index, we can consider these development factors, this study will analyze the cluster indexes of Hsinchu Science Park in the following 4 categories: (1) Economy, (2) Innovation, (3) Talent and (4) Environment. The cluster index of Hsinchu Science Park will base on this innovative infrastructure. The relationships among these 4 factors are shown in Fig.4.1, the economic outcome of cluster is decided by the innovative activities; the innovation of regional industrial cluster is derived from technical innovation, upgrading of personnel and the establishment of new business within the industry; which in turn, would be influenced by "Innovation", "Talent", and "Environment". We would show the cluster development of Hsinchu Science Park through various cluster indexes.

The following parts including different year's annual comparison of various indexes, comparisons of different counties and cities, comparisons between different industrial clusters and nation-wide comparison have been completed. The work to be completed includes the international comparison of same index and analysis of competitive power.

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4 Ma, Wei-yang (2007a), *Investigation of Science Parks' Sustainability and Competitiveness*, p48-53, TIER Review, Jan., 2007

Ma, Wei-yang (2007b), Research on the Sustainability and Competitiveness of Science Parks(2007), 2007 IASP-ASPA Conference

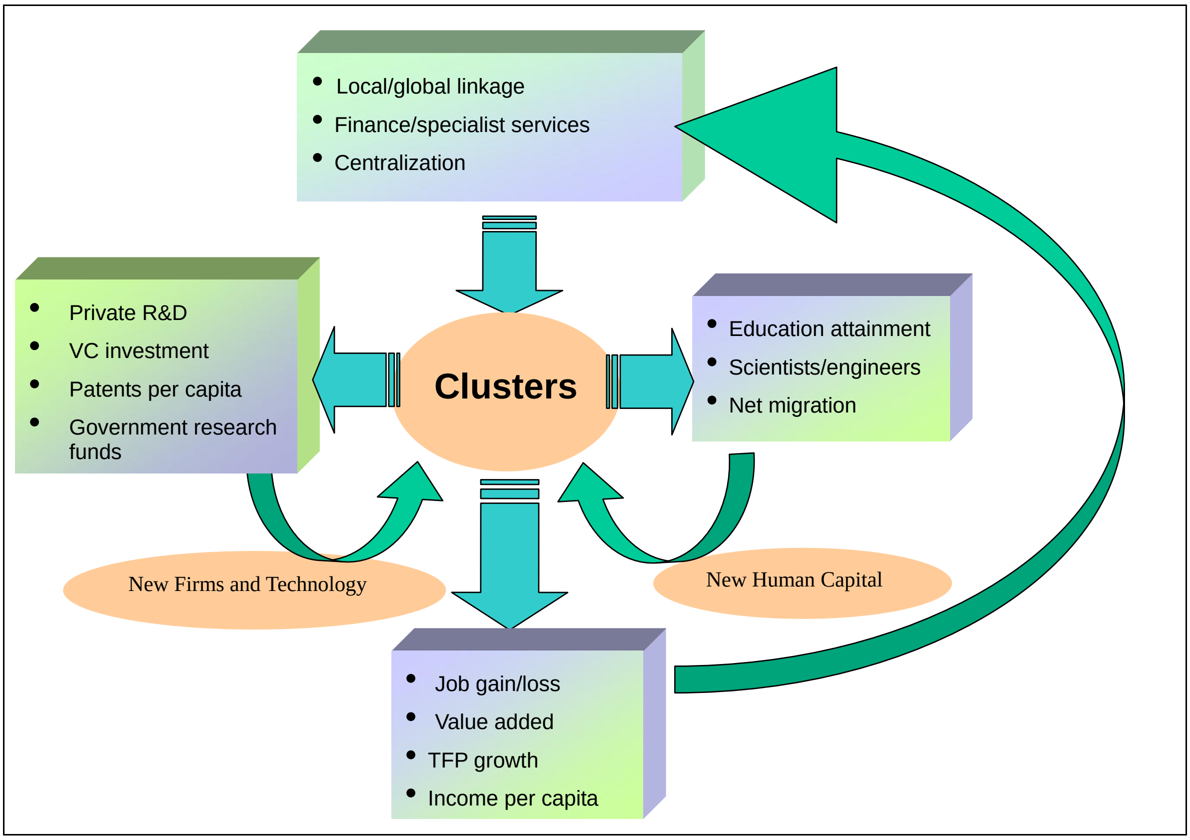


fig. 4.1. Relationship between HSP industrial cluster indicators and sub-indicators
Source:Qi, Yu-lan, Chun-xing, Huang and Rui-hua, Liu (2006)

V. 2006 HSP Innovation Cluster Indicators

5.1 Economy

This indicator contains five figures including employment ,wages ,value-added, no. of companies, income, with a view to showing HSP's performances from different aspects of economic achievements.

1. Employment

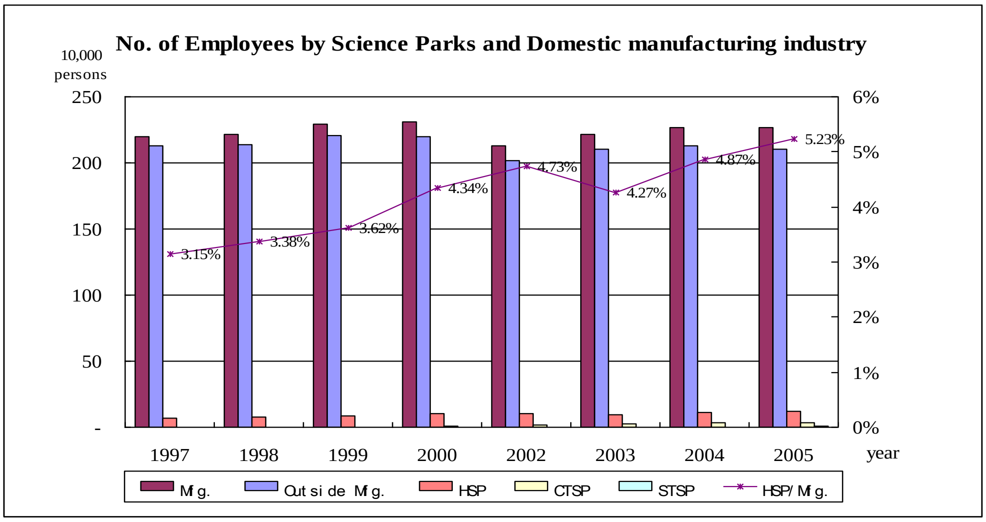
The employment indicator is comprised of two sub-indicators: no. of employees by science parks and domestic manufacturing industry,no. of employees by hsinchu science park and domestic manufacturing industry.These indicators show that:

(1) Between 1997 and 2005, HSP's total employment as a percentage of the total employment of domestic manufacturing industry rose steaily.

(2) Between 1997 and 2005, HSP's total employment as a percentage of Hsinchu County's total employment rose from 40% to 53.5%.

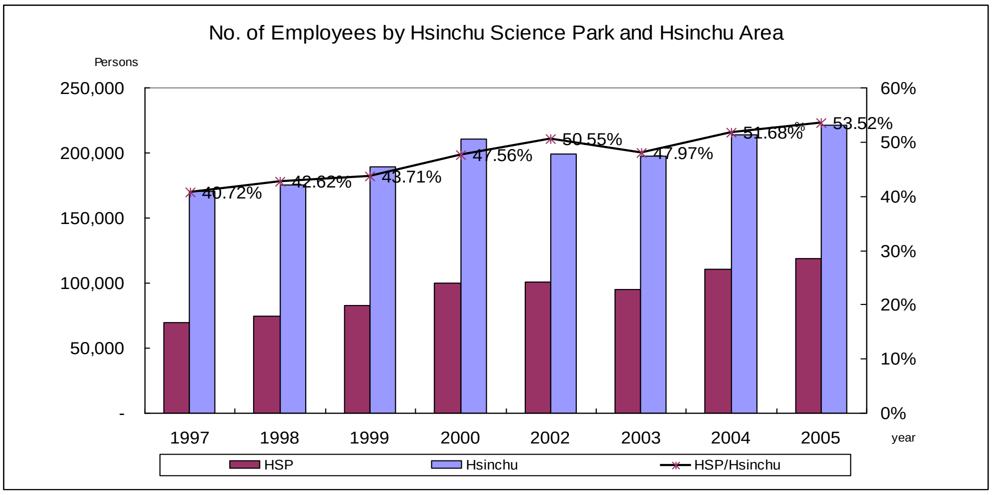
Employment sub-indicators:

1a. No. of Employees by Science Parks and Domestic Manufacturing Industry



Source: 1. Industrial Cencus Report; Ministry of Economic Affairs, R.O.C., compiled for this project.
2. Southen Science Park: STSP Central Science Park: CTSP Manufacturing Industry: Mfg Outside Manufacturing Industry:Outside Mfg

1b. No. of Employees by Hsinchu Science Park and Hsinchu Area



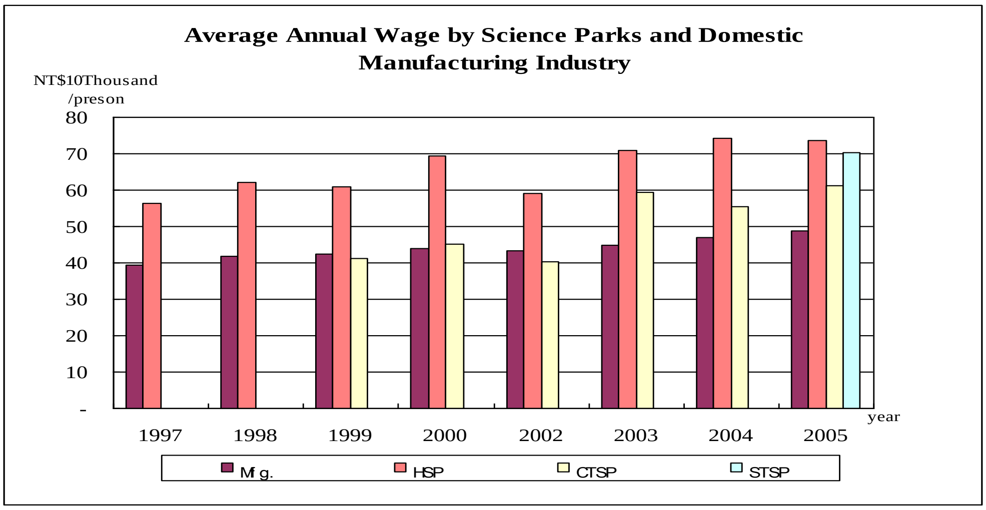
Source: ibid.,1a

2. Wages

The wages indicator is comprised of one sub-indicator: average annual wage by science parks and domestic manufacturing industry. This indicator shows that, between 1997 and 2005, HSP's average wage for its employees was on the rise and exceeds that of the domestic manufacturing industry by 36%-59%.

Wage sub-indicator:

2a. Average Annual Wage by Science Parks and Domestic Manufacturing Industry



Source: ibid.,1a

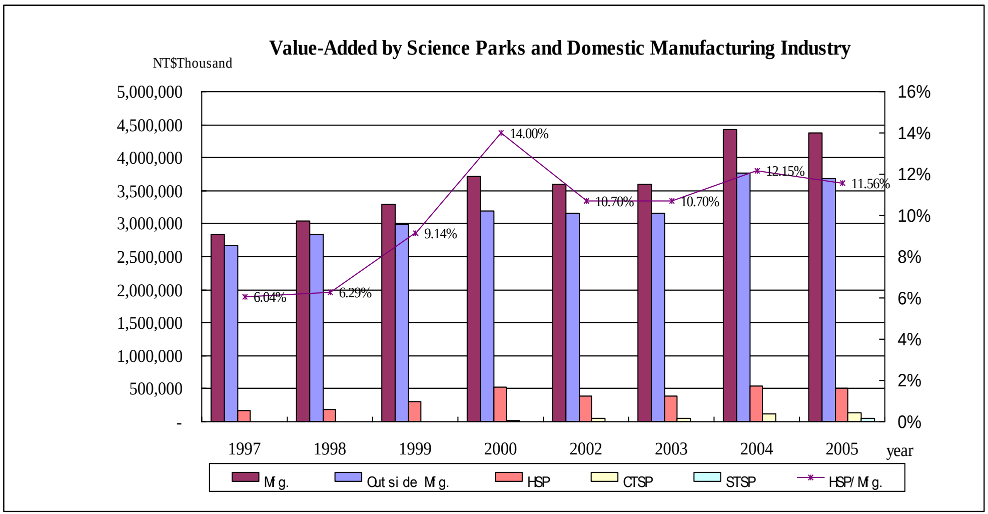
3. Value-Added

The value-added indicator is comprised of three sub-indicators:value-added by science parks and domestic manufacturing industry,value-added per capita by science parks and domestic manufacturing industry,value-added ratio by science parks and domestic manufacturing industry.These indicators between 1997 and 2005 show that:

(1) HSP's value-added per capita was on the rise, leaving out the year 2000 which was the peak.
(2) HSP's value-added ratio to the domestic manufacturing industry peaked at 2000 and slightly slided since then.
(3) HSP's value-added exceeded the domestic manufacturing industry by over 10% since 2000.

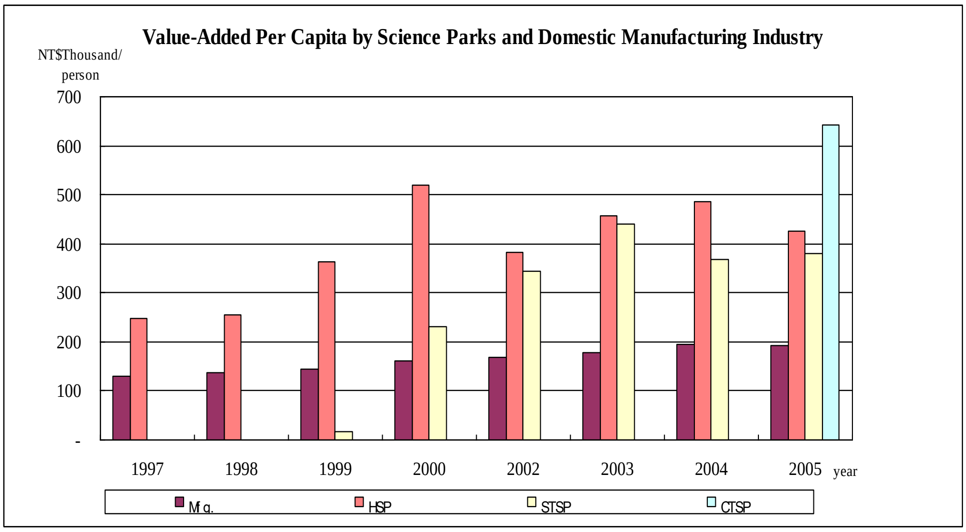
Value-added sub-indicators:

3a. Value-Added by Science Parks and Domestic Manufacturing Industry



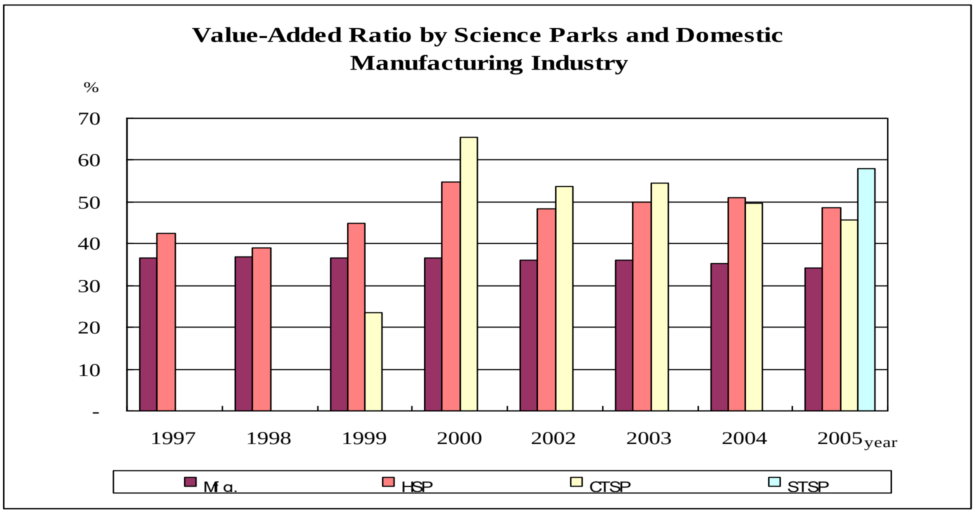
Source: ibid.,1a

3b. Value-Added Per Capita by Science Parks and Domestic Manufacturing Industry



Source: ibid.,1a

3.c. Value-Added Ratio in the Science Park by Science Parks and Domestic Manufacturing Industry



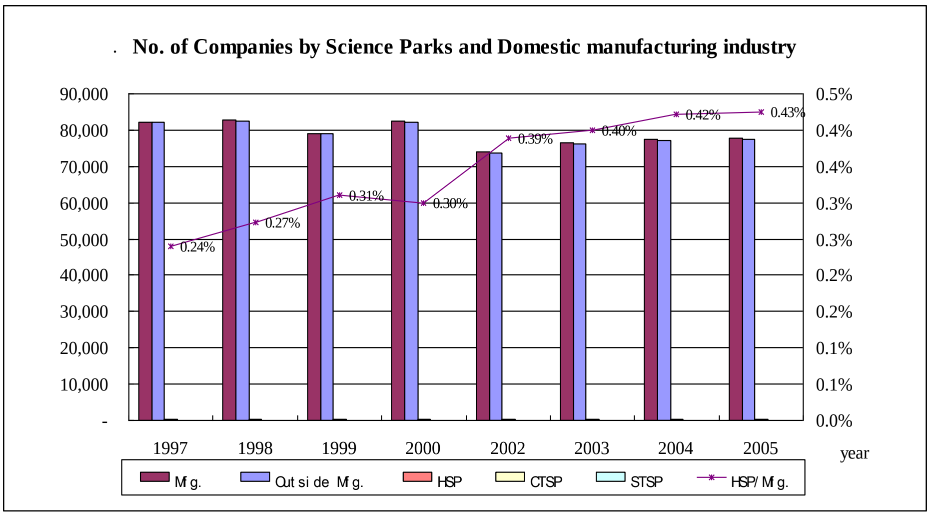
Source: ibid.,1a

4. No. of Companies

The number-of-companies indicator is comprised of one sub-indicator: no. of companies by science parks and domestic manufacturing industry.This indicator shows that, between 1997 and 2005, HSP's number of companies was on the rise, with the ration to domestic manufacturing industry rising, too.

No. of companies sub-indicator:

4a. No. of Companies by Science Parks and Domestic Manufacturing Industry



Source: ibid.,1a

5. Income

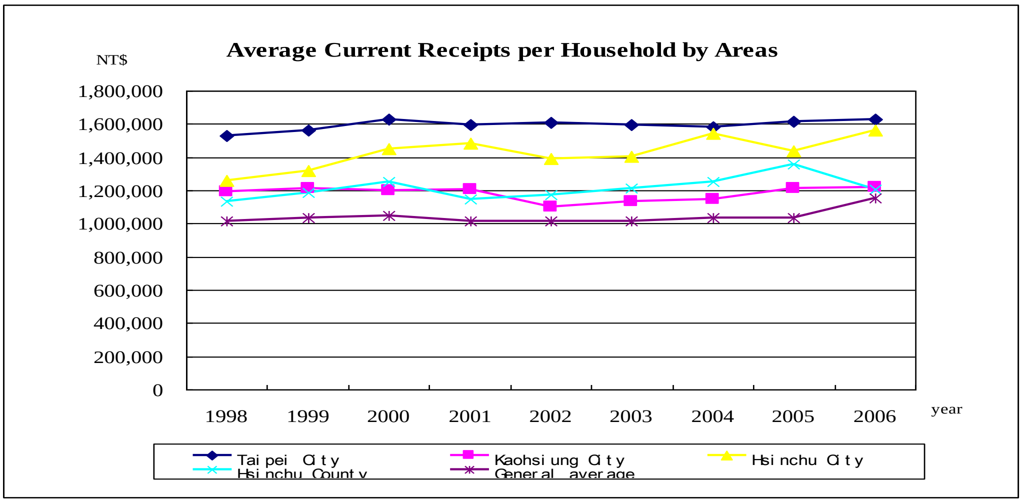
The income indicator is comprised of two sub-indicators: average current receipts per household by areas, average annual disposal income per capita by areas.This indicator shows that:

(1) Between 1998 and 2006, Hsinchu City had an average income per household ranked the second nation wide, exceeding that of Taiwan and Kahhsiung City.

(2) Between 1998 and 2006, Hsinchu City had an average income per household exceeding that of Kaohsiung City starting from 1998, with slight lag behind that of Taipei City.

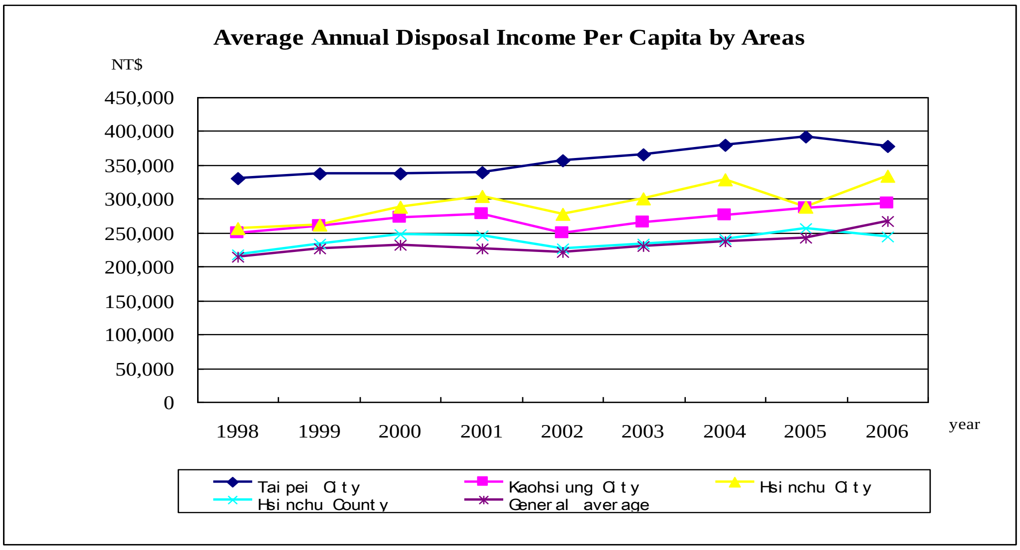
Per-household income sub-indicators:

5a. Average Current Receipts per Household by Areas



Source: Directorate General of Budget, Accounting and Statistics, Executive Yuan, R.O.C.,compiled for this project

5b. Average Annual Disposal Income Per Capita by Areas



Source: ibid.,5a

5.2 Innovation

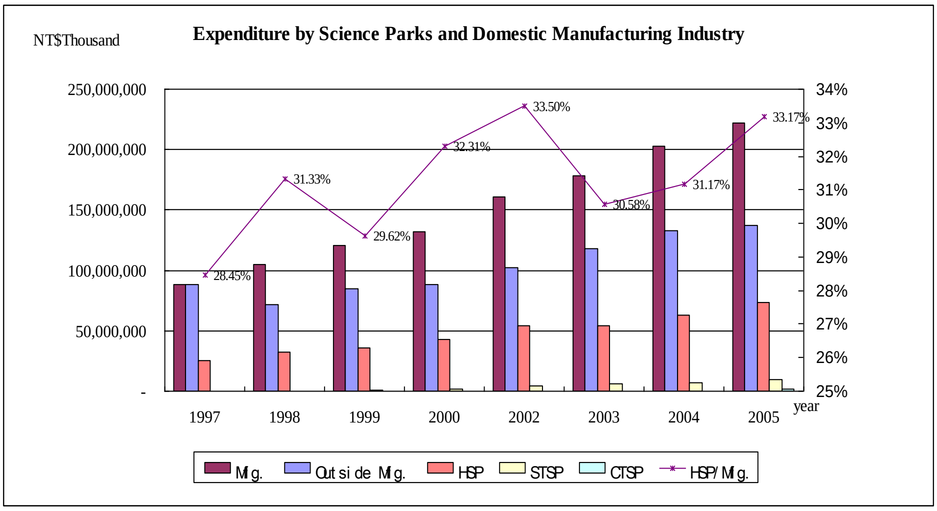
This indicator contains nine figures including R&D expenditure, R&D expenditure ratio, approved patents, technology trade, new business incorporation ,small business innovation research SBIR, with a view to showing HSP's innovation capacity from different aspects of economic achievements.

6. R&D Expenditure

The R&D expenditure indicator is comprised of one sub-indicator: R&D Expenditure by Science Parks and Domestic Manufacturing Industry.This indicator shows that, between 1997 and 2005, both nation-wide and HSP's R&D expenditure was on the rise, with HSP's figure taking up 30% of the nation-wide figure.

R&D expenditure sub-indicator:

6a. R&D Expenditure by Science Parks and Domestic Manufacturing Industry



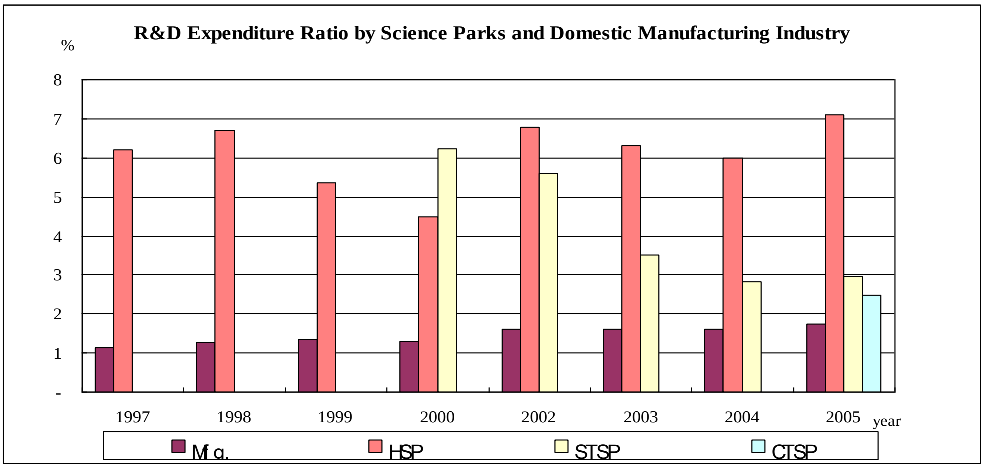
Source: ibid.,1a

7. R&D Expenditure Ratio

The R&D expenditure ratio indicator is comprised of one sub-indicator: R&D Expenditure Ratio by Science Parks and Domestic Manufacturing Industry.This indicator shows that, between 1997 and 2005, HSP's R&D expenditure ratio was 3.5-5.5 times of the nation-wide figure.

R&D expenditure ratio sub-indicator:

7a. R&D Expenditure Ratio by Science Parks and Domestic Manufacturing Industry



Source: ibid.,1a

8. Approved Patents

The approved patents indicator is comprised of two sub-indicators: Top 100 US patent grants, percentage of US patent granted for Hsinchu. These indicators shows that:

(1) HSP's top 100 US patent grants as percentage of the nation-wide figure dropped 10 percentage point from 41.5% in 2004 to 31.7 in 2006.

(2) Between 2002 and 2006, Hsinchu's US patent grants as percentage of the nation-wide figure were 18-22%.

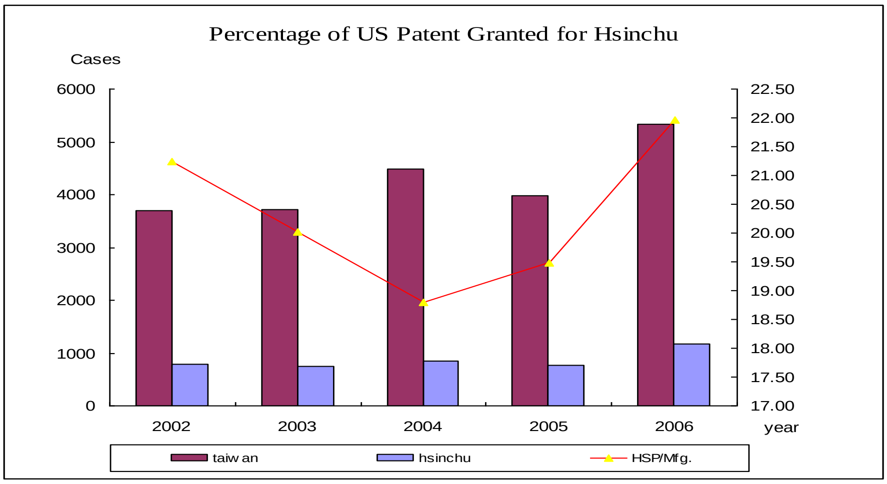
Patent application sub-indicator:

8a. Top 100 Patent Grants

2006	No of HSP	HSP	Mfg.	HSP/Mfg.
Top 10	5	954	2472	38.60%
Top 20	8	1126	3148	35.80%
Top 100	25	1474	4655	31.70%

Source: USPTO, U.S.A.; Business Week, R.O.C.,compiled for this project.

8b. Percentage of US Patent Granted for Hsinchu



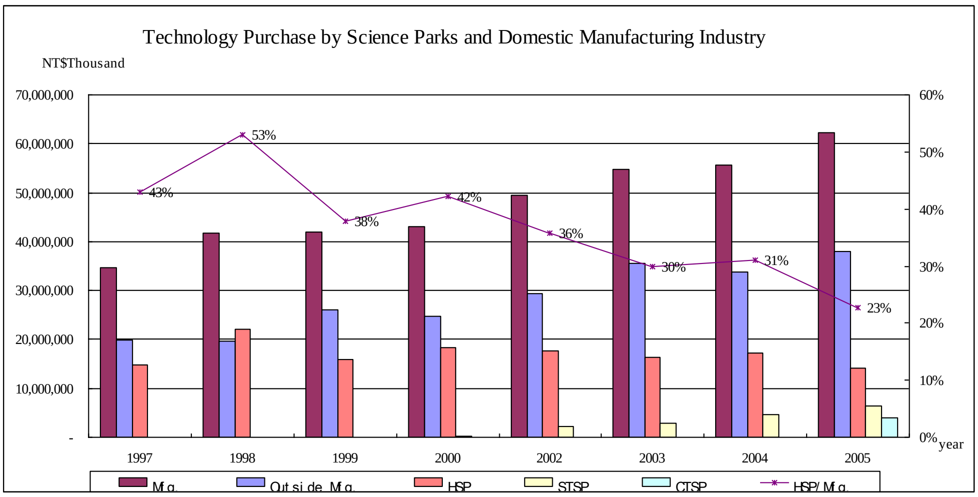
Source: ibid.,8a

9. Technology Trade

The technology trade indicator is comprised of two sub-indicators: technology purchase by science parks and domestic manufacturing industry,technology sale by science parks and domestic manufacturing industry.These indicators show that: Between 2002 and 2005, HSP's technology purchase ratio decrease while technology sale ratio increased, indicating its achievements in the development of independent technology.

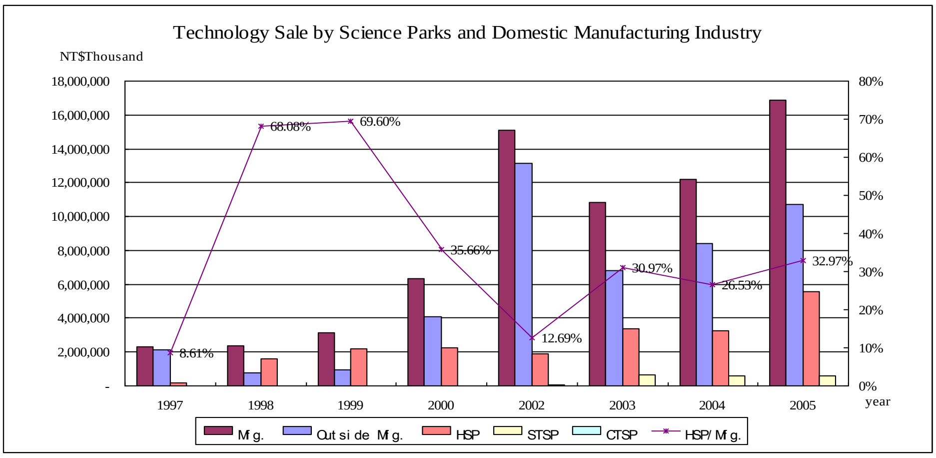
Technology Trade Sub-indicators:

9a. Technology Purchase by Science Parks and Domestic Manufacturing Industry



Source: ibid.,1a

9b. Technology Sale by Science Parks and Domestic Manufacturing Industry



Source: ibid.,1a

10. New Business Incorporation

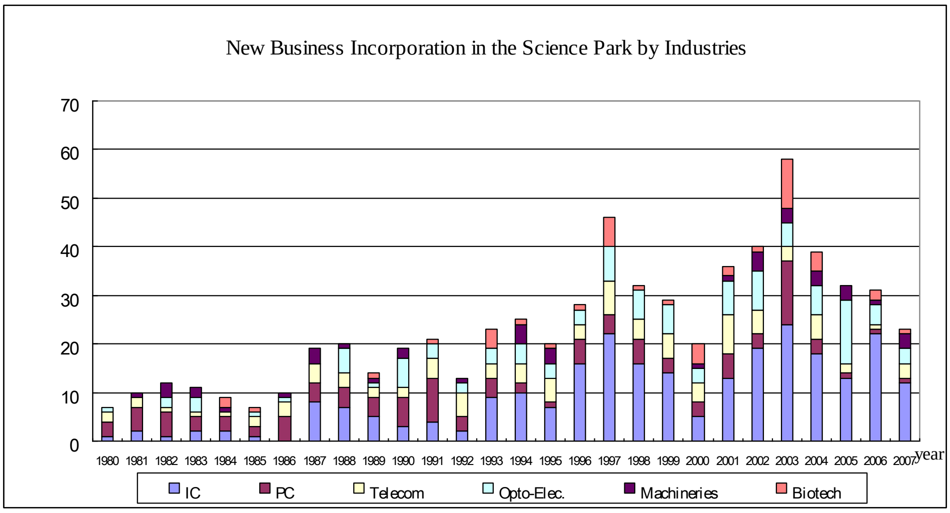
The new business incorporation indicator contains one sub-indicator: new business incorporation in the science park by industries.This indicator shows that:

(1) Since HSP's establishment in 1980, the number of new companies incorporated peaked at 1997 and 2003, with an average of 20-40 new companies formed annually between 1987 and 2007.

(2) Between 1980 and 1990, most of the newly incorporated companies were in the business of personal computer and peripheral industries. The trend was taken over by IC industries after 1990 and the electricoptical industries have been on the rise since 2000.

New business incorporation sub-indicators:

10a. New Business Incorporation in the Science Park by Industries



Source: HSP Adminstration, compiled for this project.

11. Small Business Innovation Research

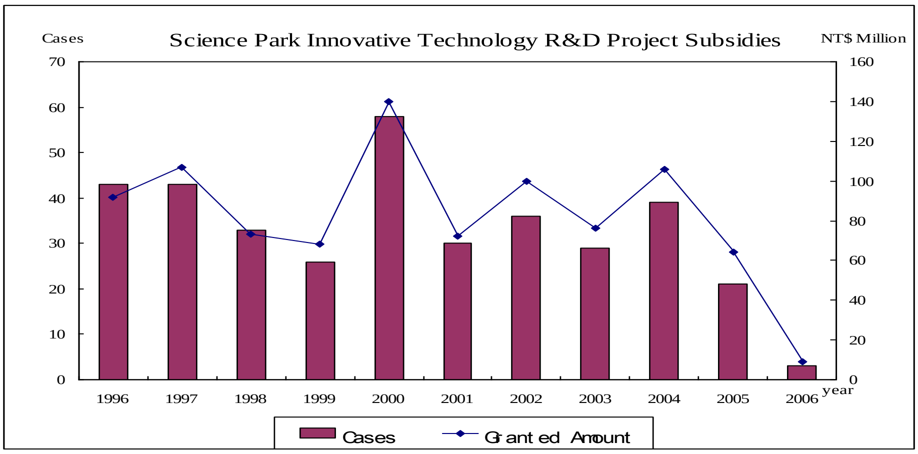
The SBIR indicator is comprised of two sub-indicators: the science park innovative technology R&D project subsidies and science park innovative technology R&D project subsidies percentage. These indicators show that:

(1) Between 1996 and 2006, the dollar amount and number of R&D projects receiving governmental subsidies peaked at 2000, with trough being in 2006.

(2) Between 1996 and 2006, an average of 25% of R&D projects received governmental grants. Starting in 2001, grants has seen a downward trend.

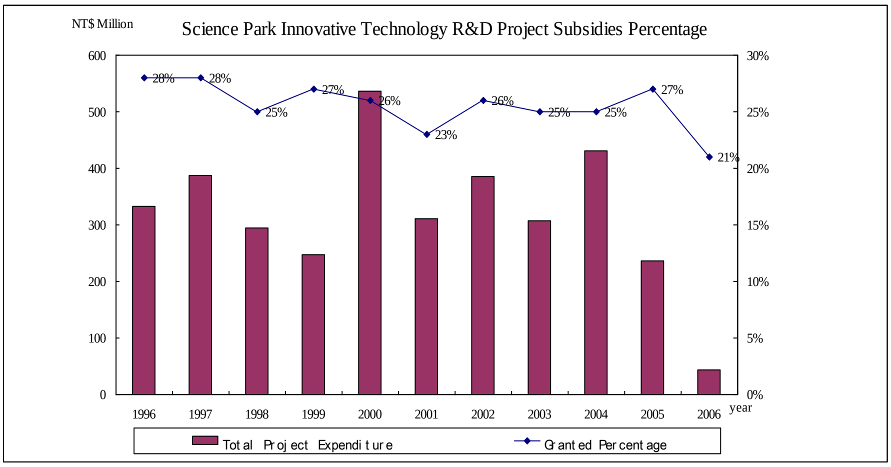
Sub-indicators for Governmental R&D Subsidies:

11a. Science Park Innovative Technology R&D Project Subsidies



Source: ibid.,10a.

11b. Science Park Innovative Technology R&D Project Subsidies Percentage



Source: ibid.,10a

5.3 Talent

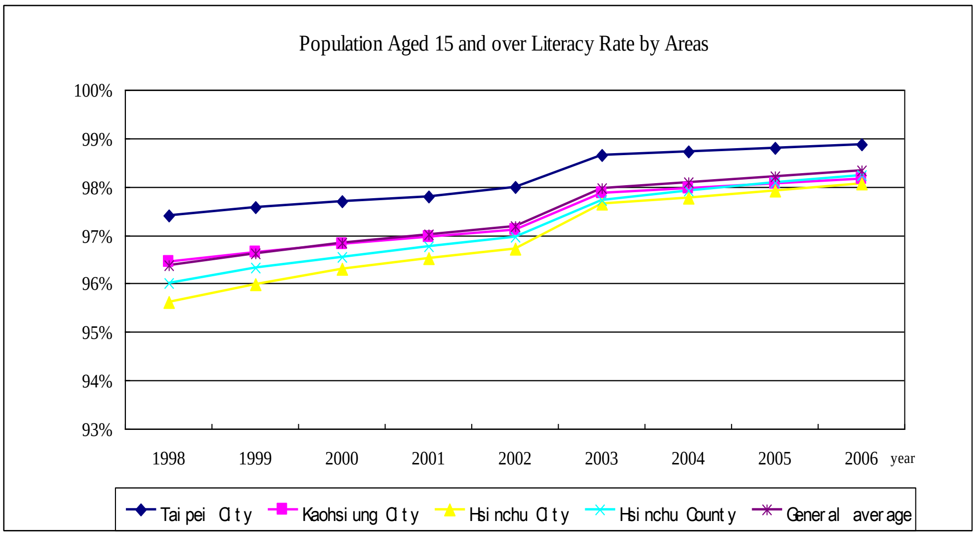
This indicator includes three figures including literacy rate, primary education, higher education, for evaluation of the quantity and quality of HSP's potential human resources.

12. Literacy Rate

The literacy rate is represented by a sub-indicator: Population Aged 15 and over Literacy Rate by Areas.This indicator shows that the Hsinchu population literacy rate slightly lags behind that of Taipei and Kaohsiung, despite its approaching 98% with an ascending trend. The nation-wide statistics show little variations among regions.

Literacy rate sub-indicator:

12a. Population Aged 15 and over Literacy Rate by Areas



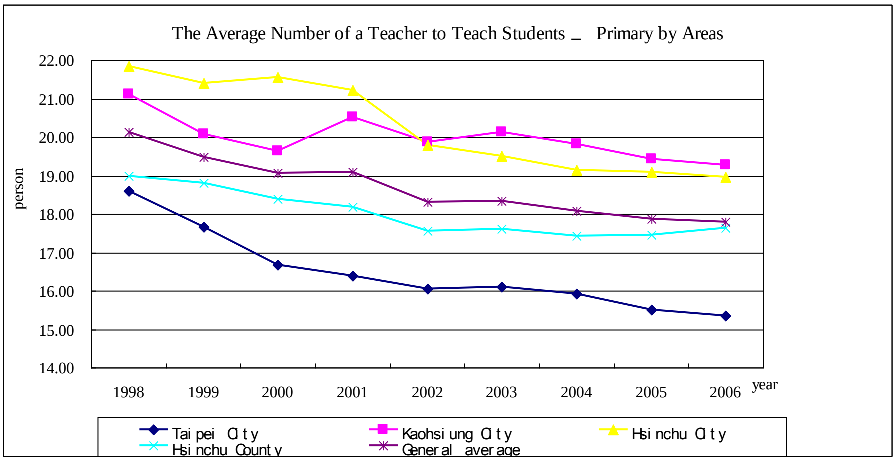
Source: ibid.,5a

13. Primary Education

The primary education indicator is represented by a sub-indicator: The Average Number of a Teacher to Teach Students - Primary by Areas.This indicator shows that Hsinchu's primary education has been steadily enhanced in its quality and scored bettern than Kaohsiung since 2002, but still lags behind that of Taipei and the whole Taiwan area.

Primary Education Sub-indicator:

13a. The Average Number of a Teacher to Teach Students – Primary by Areas



Source: ibid.,5a

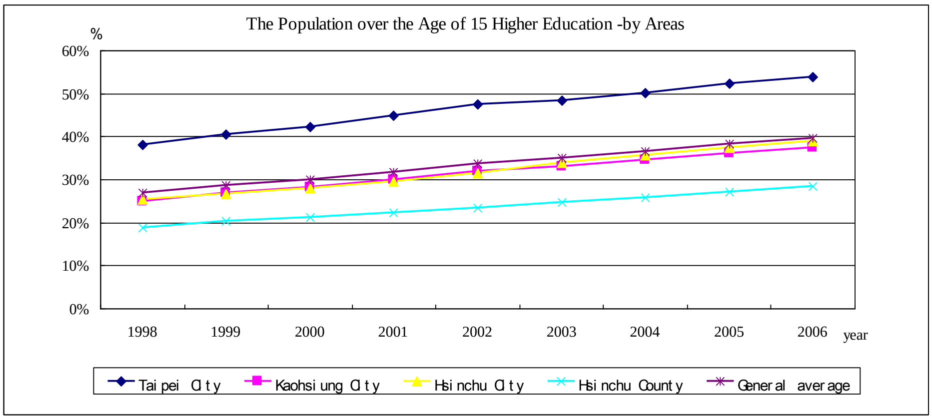
14. Higher Education

The Higer Education indicator is comprised of three sub-indicators: the population over the age of 15 higher education -by areas, no. of employees with doctors or masters degrees in the science park and domestic manufacturing industry, no. of employees with bachelors degrees and above in the science park and domestic manufacturing industry.These indicators show that:

(1) Hsinchu City's population aged 15 and over receiving higher education is of about the same rate as that of Kaohsiung City, slightly higher than that of Taiwan area but lower than that of Taipei City. Hsinchu County has a rate lower than these areas.
(2) Between 2001 and 2006, HSP has a percentage of employees with Master or Phd degrees exceeding that of the domestic manufacturing industry by 14% to 16%.
(3) Between 2001 and 2006, HSP has a percentage of employees with Bachelor's or higher degrees exceeding that of the domestic manufacturing industry by 17% to 20%.

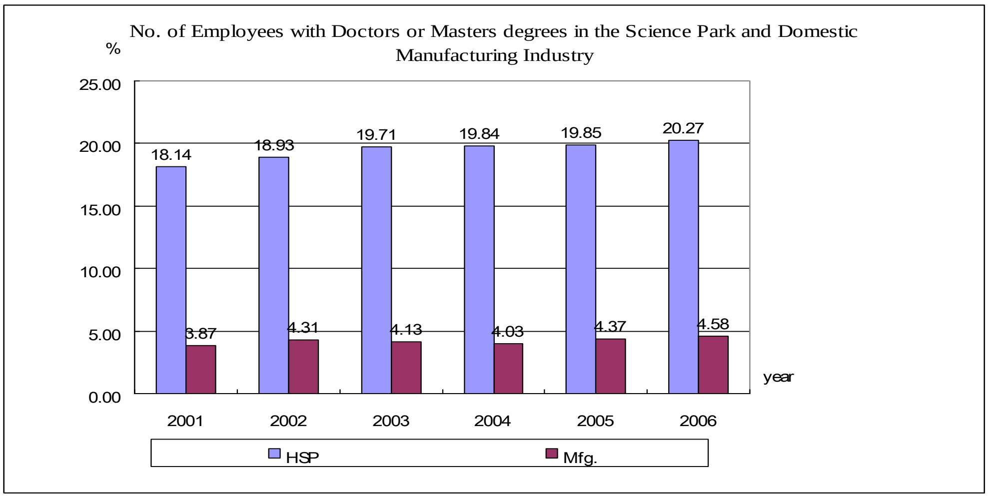
Higher Education indicator:

14a. The Population over the Age of 15 Higher Education - by Areas



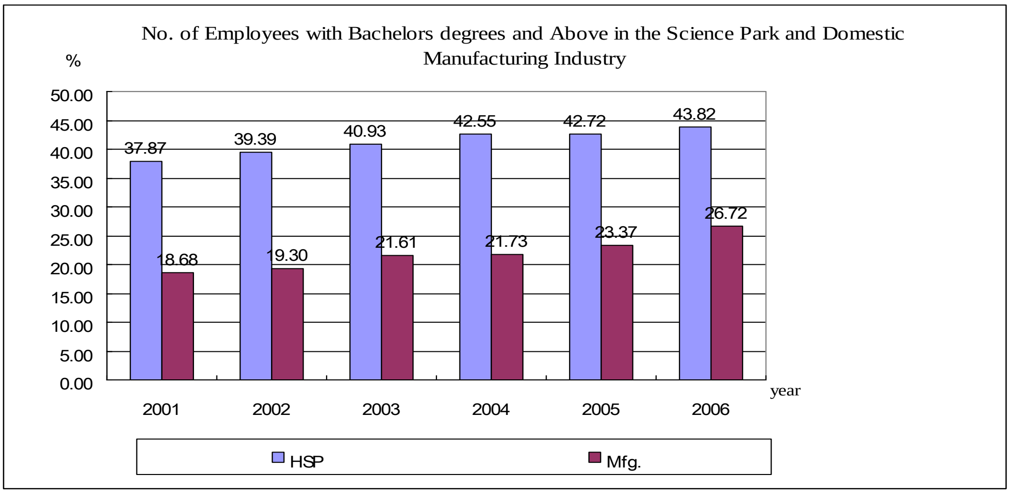
Source: ibid.,5a

14b. No. of Employees with Doctors or Masters degrees in the Science Park and Domestic Manufacturing Industry



Source: ibid., 5a&10a

14c. No. of Employees with Bachelors Degrees and Above in the Science Park and Domestic Manufacturing Industry



Source: ibid.,14b

5.4 Environment

This indicator is comprised of five figures including specialty, science and technical service, vacancy rate ,internet utility ,public servant ,air quality to assess the quality of HSP's hardware and software environment

15. Specialty, Science and Technical Service

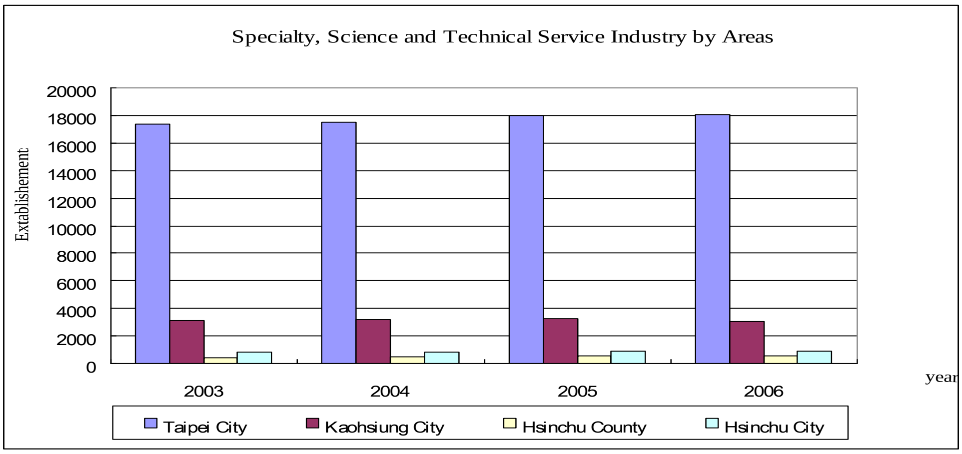
The specialty, science and technical service indicator is represented by a sub-indicator: Specialty, Science and Technical Service Industry by Areas.The indicator shows that:

(1) There are 883 services in 2006, compared to 833 in 2003, for Hsinchu City. There are 555 services in 2006, compared to 410 in 2003, for Hsinchu County.

(2) The rate of growth is 35.37% for Hsinchu County and 6.0% for Hsinchu City, compared 3.95% for Taipei City and -3.2% for Kaohsiung City.

Specialty, science and technical services sub-indicator:

15a. Specialty, Science and Technical Service Industry by Areas



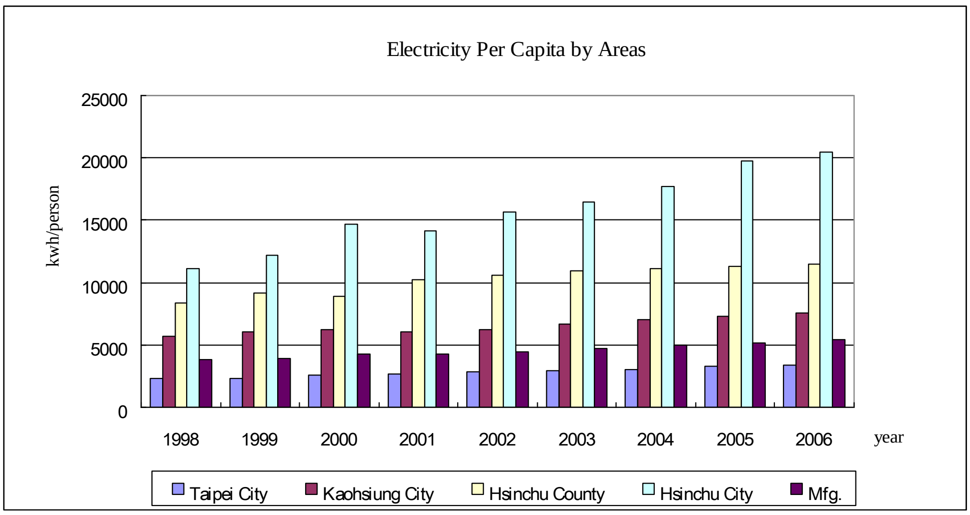
Source: Ministry of Economic Affairs, R.O.C.,compiled for this project

16. Electricity

The electricity indicator is represented by a sub-indicator: Electricity Per Capita by Areas.The indicator shows that Hsinchu City has a constantly growing demand for electric power at a rate similar to that of Taipei City, Kaohsiung City and the whole nation. However, both Hsinchu City and Hsinchu County have an annual compound growth rate far exceeing Taipei City, Kaohsiung City and nation-wide figures.

Electricity sub-indicator:

16a. Electricity Per Capita by Areas



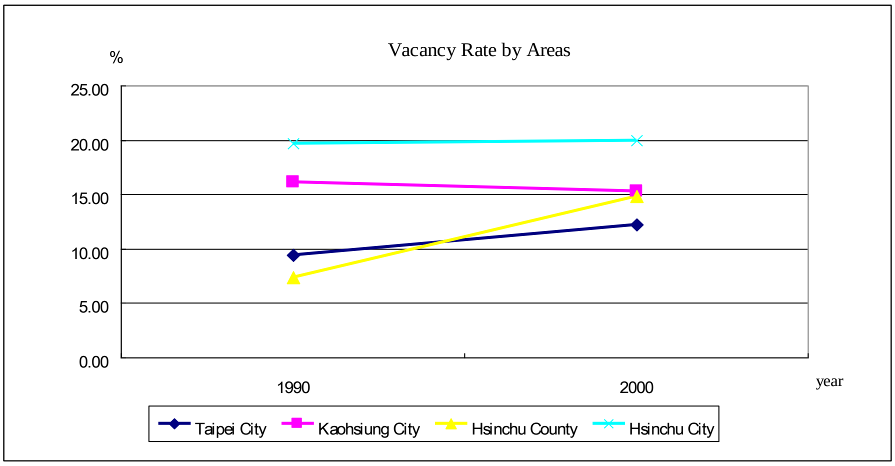
Source: Taiwan Power Company,compiled for this project

17. Vacancy Rate

The vacancy rate has one sub-indicator: vacancy rate by areas. The indicator shows that Hsinchu City's vacancy rate has been descending in the past decade while Taipei City's, Kaohsiung City's and nation-wide vacancy rates have been rising.

Vacancy Rate Sub-indicator:

17a. Vacancy Rate by Areas



Source: 1. :ibid.,5a
2. The census is conducted every 10 years.

18. Internet Utility

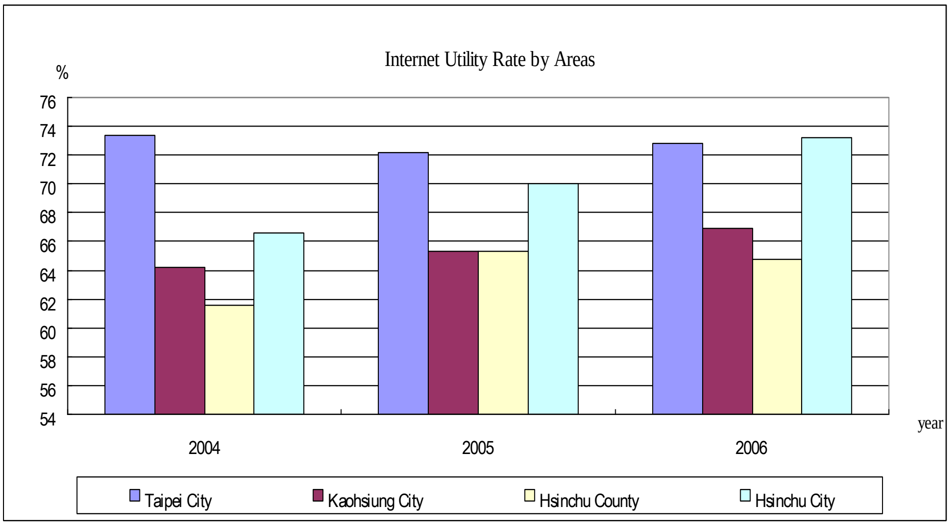
The Internet utility indicator contains two sub-indicators: internet utility rate by areas, percentage of household with internet facility by areas.These indicators show that:

(1) Hsinchu City has an Internet utility rate of 73.2% in 2006, exceeding Taipei City's 72.8%

(2) Hsinchu City has 69.5% of household with Internet facility in 2006, ranked the second in the nation-wide figures, slightly lagging behind Taipei City's 72.4%.

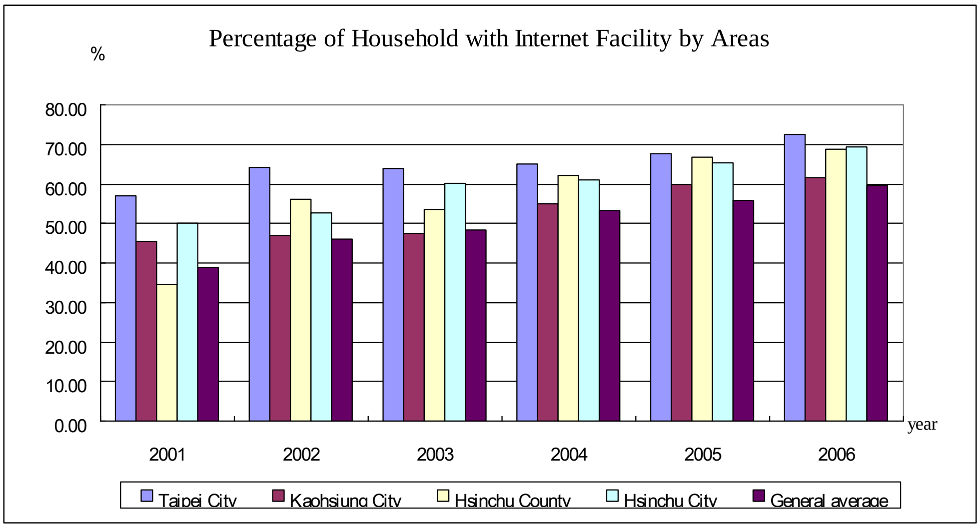
Internet Utility sub-indicators:

18a. Internet Utility Rate by Areas



Source: 2006 Digital Divide Report on Taiwan and Fukien Areas, published by Research, Development and Evaluation Commission, Executive Yuan

18b. Percentage of Household with Internet Facility by Areas



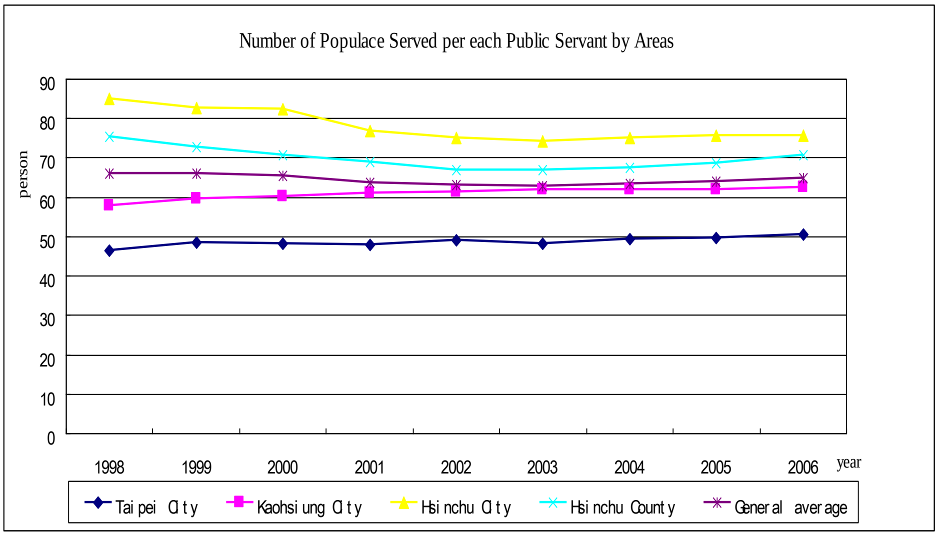
Source: ibid.,18a

19. Public Servant

The public servant indicator contains one sub-indicator: number of populace served per each public servant by areas.This indicator shows that:The number of populace served per each public servant was descreaing in Hsinchu City and Hsinchu County, while increasing slightly in both Taipei City and Kaohsiung City.

Public Servant sub-indicators:

19a. Number of Populace Served per each Public Servant by Areas



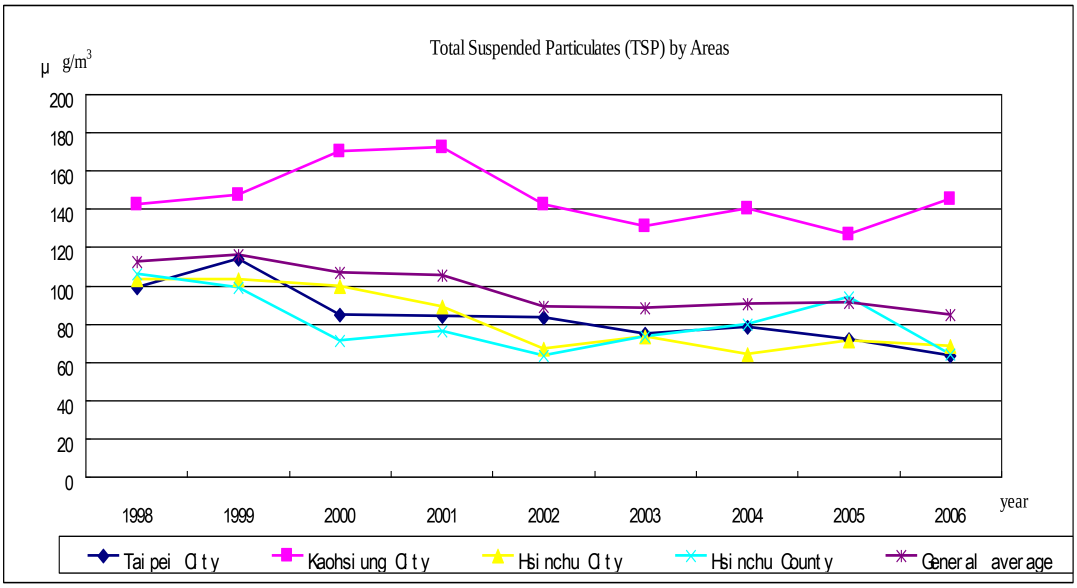
Source: ibid.,5a

20. Air Quality

The air quality indicator contains one sub-indicator: total suspended particulates (TSP) by areas.This indicator shows that:Kaohsiung City ranked first in 2006 in the total suspended particulates by areas, followed by Taipei City and Hsinchu City in sequence, with Taiwan area being the lowest.

Air Quality sub-indicators:

20a. Total Suspended Particulates (TSP) by Areas



Source: ibid.,5a

VI. Conclusion and Recommendations

This paper analyzes the arising of industrial clustering effects based on a framework of innovation formed of four factors, from which Hsinchu City receives the most significant impact, followed by Hsinchu County. In the following are described some of the specially manifested features:

1. Economy: HSP's total employment exceeded 100 thousands people since 2000, taking up over 50% of Hsinchu County's total employment since 2006, which means one out of every two employments in Hsinchu County was working in HSP. The average wage of HSP's employees exceeds the nation-wide figure by 40%-60%, making Hsinchu City's income and consumption top in Taiwan area. In 2006, Hsinchu City's average annual disposable income per household ranked the second among the nation-wide figures, being second to Taipei City. (Only Taipei City and Hsinchu City have disposable income per household exceeding NT$1 million.) Hsinchu City's average annual disposable income per capita was also second only to Taipei City's, with income from employment per household exceeding Taipei City's, topping those of Taiwan area. In 2006, the average consumption per household exceeded Taipei City's to top those of Taiwan area. On the hand, Hsinchu City's labor participation rate in 2006 reached 60.8%, the highest figure in six years and topping those of Taiwan area. The female labor participation rate also ranked the first nation-wide. Additionally, the unemployment rate was dropping in the fifth consecutive year. HSP's impact on local economies is obvious.

2. Innovation: HSP's R&D expenditure is about 30% of total national R&D expenditure. Its technology purchase and sale is also about 30% of the total national figures, with raito of purchase gradually exceeding ratio of sale. HSP's US patents granted is over 20% of total national figure. Among the national top 100 companies in terms of R&D expenditure and patents granted, more than 30 are in HSP. Combining the peripheral academic institutions such as ITRI, National Applied Research Laboratories, National Tsinghua University and Nationa Chiaotung University, Hsichu has established its position as Taiwan's innovation industrial cluster.

3. Talent: HSP has a percentage of employees with higher education (those with Master or Phd degrees) far exceeding that of the domestic manufacturing industry. HSP has actually pooled many of Taiwan's top-class talents (especially in the field of science and technology).

4. Environment: Hsinchu City tops in the nation-wide power consumption, both in production and in daily lives. It also exceeds Taipei City in 2006 and 2007 to top in the nation-wide ranking of degree of being digital. It is the top city of digital development, with leading Internet utility indicators. Hisnchu City also shows well developed hard and soft infrastructures, revealed by the nation-wide top ranking number of populace served per each public servant and environmental (air) quality.

Apart from research institutions and universities into the future should be included in a number of important indicators are as follows:

1. Environment indicators
2. Revenue indicators
3. IPOs and M&A indicators
4. Investment capitals indicators
5. Human resource indicators

6. Housing prices and the percentage of owned houses

Indicators need to be dynamically adjusted for quick response to globalization and to compete in fierce market domestically and abroad. In the following are listed some suggestions with regard to strengthening talents, capital and technology of the clusters.

1. HSP needs to establish its own innovation habitat

HSP has successfully incubated Taiwan's high-tech industries through the development stage, with achievements mainly focused in manufacturing. For ongoing and sustainable growth into the future, sources must be cultivated for technology innovation. HSP's international connection, one of its critical relied-on factors, is facing ever-growing challenge as a result of economic globalization and emergence of competitors. HSP is therefore in urgent need of more decisive advantage in order to boot its industrial competitiveness globally. Decisive advantage can be achieved through, besides establishing the aforementioned advantageous conditions, focusing on the stragegy based on the perspective of innovation economy to reinforce clustering effects of existing enterprises as well as to transform HSP into an innovation habitat that will host promising new enterprises. This environment will then enhance innovation activities among existing enterprises and attract innovative enterprises by the industrial clustering effects. The result will be synergetically augmented innovation cluster effects.

2. HSP needs to become the community for talents of science and technology in global economy

Talents apparently are more discriminative than technology and capital in their seeking of right environment to move to. Even if technology and capital may make short-term movement according to the condition of resources, they eventually follow talents to settle somewhere. This applies in the cross-strait economic interaction as well. Variations in economic conditions like cost and market will inevitably drive more Taiwan businessmen to invest in China for production, while Taiwan's clustering environment is critical in maintaining a talent advantage. Even with high mobility due to globalization, the Taiwan talents in science and technology will still see HSP as an ideal hometown so long as it provides them with a good living environment.

HSP will continue functioning as the vitality source for Taiwan's enterprises by maintaining entrepreneur innovation, attracting local and foreign talents, and attracting venture capitalists. Besides improving the quality of education and proposing measures for recruiting foreign talents, the capability to attract outstanding foreign students to study in Taiwan will allow HSP to sustain subsequent attraction, generation and exchange of global talents, creativity and business practices.

3. Government needs to be proactively implementing the development

The government may have to guide or coordinate manufacturers to focus on the development of certain key industries. Examples of these kinds of efforts include HSP, the IC , TFT-LCD policy and biomedical industries.

Land planning is a critical condition for the formation of an industrial cluster. The government used to complete the construction of an industrial zone before recruiting of enterprises, without first considering the special industrial clustering needs of manufacturers. In recent years, the government has changed its way of dealing with such issues by quickly providing cluster-effective lands to enterprises according to their needs.

The government should also assist existing or developing industrial clusters of which the lacked key and coordinating industries need to be attracted.By taking advantage of the high-speed railway transportation and the major investments made in the vicinity of the high-speed railway stations, the Western Taiwan district will become an area where many enterprises and releated industries can easily connect with each other to attain ultrahigh clustering effects that are rarely seen elsewhere globally. Such an advantage will enable Taiwan to maintain its strong industrial cluster competitiveness.

Based on the above observation and the analysis of various trends, Taiwan is in urgent need of a set of well constructed innovation cluster indicators, as well as continued long-term efforts in the accumulation and comparison of data for these indicators. The future study should be directed towards the adjustment of the indicator set and establishment of new indicators, along with comparison on international basis. The purpose is to establish a meaningful set of innovation cluster indicators through which industries, academic institutions and governmental organizations can achieve better and clearer global positioning when doing planning and making decisions.