An Analysis Model for Knowledge-Based Industry Development from Cases Study of China

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Abstract

Purpose: The development of knowledge industries is considered as the basis as well as the motor force of knowledge-based urban development (KBUD). In fact, the decline or stagnation of knowledge industries has always led to the failure of "Knowledge City (KC) Strategy" in some cities. Based on the case studies on several selected cities of China, we attempt to identify the key factors for the success of knowledge industries and thus to establish an integrated analysis framework for the knowledge industry development. Any city oriented to KC can use this model to analyze its situation for the development of knowledge industries as well as to formulate a right action plan.

Design/methodology/approach: Select five cities of China as for case studies. Examine and analyze their successful experiences on developing different knowledge industries in order to illustrate whether the key factors for their success still supported by the factor hypotheses revealed in The Diamond Model Theory (an analysis model for industrial competitiveness). Then, from the growth of key factors perspective and with our previous related work, an integrated analysis model for the knowledge industry development including the analysis process and related assessment methods is proposed in the end.

Findings: Six main factors are critical for the success of knowledge industry. Each main factor also contains some sub factors. Comprehensive analysis of a city's strengths, weaknesses, chances and threats in these factors is highly valuable for identifying the city's resources and capabilities for the knowledge industry development and its special development approach.

Research limitations/implications: The cities selected as for case studies are only located in China, consequently, the proposed suggestion for future research is to incorporate other successful cities in the world into our study in order to make the proposed model receive more test and improvement.

Practical implications: This analysis framework is adapted to any city. It can provide useful information for the urban authority to recognize its current situation for the knowledge industry development. Thus, it is good to support the formulations of related strategy and detailed action plans.

Originality/value: The framework described in this paper is not only a conceptual model, but also an explicit assessment method of the crucial factors for the development of knowledge industries. In addition, the conclusions of case studies successfully indicate the common features of knowledge-based urban development of China. Their successful experience will provide useful reference for other cities.

Key words: Knowledge-based industry; Case study; Key factors for development; Analysis model

INTRODUCTION

"Knowledge City (KC)" is a new concept of urban development in the 21st century. Nowadays, more and more dynamic and innovative cities around the world are selecting "Knowledge City" as the urban strategies. A clear trend is that the development of knowledge industry has become the core of urban economic planning oriented by the knowledge-based development strategy (OECD,

2011). Many Studies show that the main reason for the success of many international knowledge cities lies in their successful transition from the traditional industries to the knowledge-based industries, such as Singapore of Asia, Melbourne of Australia, Austin of United States, Dublin of Germany, etc. (Ergazakis, Metaxiotis, & Psarras, 2004; Wong, Millar, & Chong, 2006; Yigitcanlar, 2009). Although many cities have placed the knowledge-based industry development in the priority of urban agenda, the lack of a systematic approach of assessing its conditions for developing the knowledge industries often enable the urban government unable to act properly. For example, it may leads the urban authorities overlook its successful factors as well as the risks and thus make some mistakes in knowledge industry positioning. In a word, formulating a comprehensive analysis model for the knowledge industry development is very necessary.

As the recent literature indicates, the creative industry based on knowledge has become the main driver of urban development currently. Clarke (2001) pointed out that the knowledge-based economy is highly depended on the quality and stock of human capital (P. 189). Lever (2002) also has revealed the strong correlating between the knowledge-base with a city's economic growth (P. 870). Dvir and Pasher (2004) underlined urban innovation engine as its importance for knowledge–based urban development (p. 18). In addition, some of other scholars also discussed some successful practices of the knowledge industry development by case studies (such as Ergazakis, Ergazakis, Metaxiotis, & Charalabidis, 2009; Yigitcanlar, 2009). Of course, these studies are very useful for urban knowledge industry development and our research is also benefit from them greatly, but few studies focus on the special factors for the knowledge industry development and even on the formulation of an integrated analysis framework for it.

The purpose of this paper is to pay close attention to the crucial factors contributing to the success of knowledge industries in the cities of China. The authors consider six competitiveness factors, introduced in Diamond Model Theory, as the hypotheses of success

factors for knowledge industries. Five different type of cities in China are selected as for case studies in order to examine whether the cities' success still support these hypotheses and in what level. Based on the result of case studies, we attempt to design a comprehensive analysis framework for knowledge industry development basically aiming to enhance the growth of urban knowledge industries.

The paper is set up as follows: Firstly, "Diamond Model Theory" with six key factors is briefly introduced and explained. Next, five cities of China with the different success in the knowledge industry development are taken as for case studies. Then, based on the conclusions above, a comprehensive analysis model, including four phases and related analysis methods are proposed and discussed in the end of this paper. Of course, the key findings and suggestion for further study are also highlighted finally.

1. METHODOLOGY AND CONCEPTUAL MODEL

The inspiration of the analysis framework proposed in this paper stems from "Diamond Model Theory" (a competitiveness analysis model for the traditional industries) illustrated by M. E. Porter, a professor of Harvard University, in his book "*The Competitive Advantage of Nations*" in 1990. Although some scholars, such as Padmore and Gibson (1998); Furman, Porter, and Stern (2002); Hu and Mathews (2005) revised this model in the later, the key factors for identifying industrial advantages put forward firstly in the Diamond Model is not changed. According to Porter, the development capability of one industry (competitiveness) in a region highly depends on four main factors and two additional ones. Four main factors include factor conditions, demand conditions, related and supporting industries, firm strategy structure and rivalry. Two additional factors are the chance and the government. For the industry development, six factors influence each other and form an interrelated system which is just like a diamond (as shown in Figure 1), so-called "The Diamond Model".
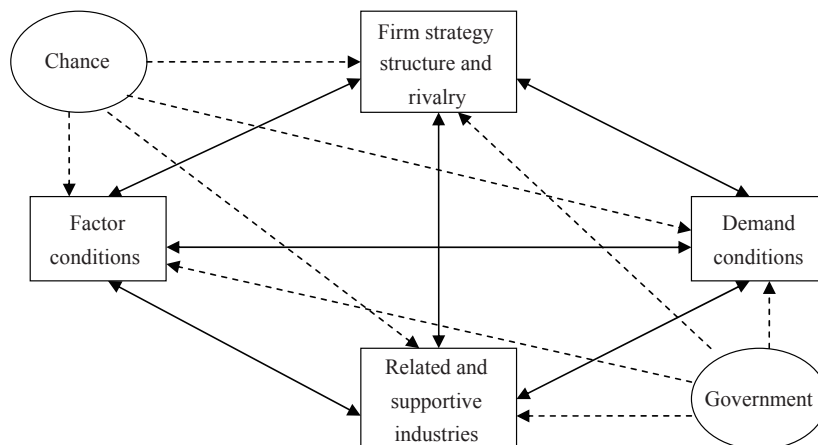

Figure 1
The Diamond Model for Industrial Development Analysis
Source: Adapted from Michael E. Porter (1990)

According to this model, four determinants for an industry's success contain:

a) **Factor conditions**. Contain knowledge resources, human resources, physical resources, capital resources and infrastructure. Specialized resources are often critical for an industry and important for its competitiveness. Specific resources can be created to compensate for factor disadvantages.

b) **Demand conditions**. In the home market, demand can help companies create a competitive advantage, when sophisticated home market buyers pressure firms to innovate faster and to create more advanced products than those of competitors.

c) **Related and supporting industries**. Produce inputs which are important for innovation and internationalization. These industries provide cost-effective inputs, but they also participate in the upgrading process, thus stimulating other companies in the chain to innovate.

d) **Firm strategy, structure and rivalry**. The way in which companies are created and managed is important for an industry's success. But the presence of intense rivalry in the home market is also important; it creates pressure to the innovation in order to upgrade competitiveness.

For the industry development, these four factors above influence each other and form a basic diamond structure. Besides, two additional factors also should not be ignored:

a) **Government**. Government can influence each of the above four determinants. Clearly government can influence the supply conditions of key production factors, demand conditions in the home market and competition between firms. Government interventions can occur at local, regional, national or supranational level.

b) **Chance**. Although its occurrence is outside of control, chance is important because it can create discontinuities in which some gain competitive positions and some lose.

An essential problem successfully solved by the Diamond Model is what key factors lead to competitive advantages (i.e. successful development) of a certain traditional industry. However, the knowledge industry is different from the traditional industry, thus whether the Diamond Model still support the knowledge industry analysis is worth studying. That is why we select the Diamond Model as theoretical basis for our research. In order to carry out the following case studies, it is necessary to briefly introduce the six factors of the Diamond Model firstly. Of course, these factors will be assumed as hypotheses of key factors for the success of knowledge industries.

2. DEVELOPMENT OF KNOWLEDGE INDUSTRIES: URBAN CASES OF CHINA

China is now making plans for economic transformation that has created a clear shift from the traditional industries to the high-tech industries. Many new knowledge-intensive industries are embedded in *"The National Future Strategic Planning of China"*. In the context, many cities of China have carried out some effective strategies for the knowledge industry development and gained much success. Next, we will select five typical cities located in different areas of China as cases to discuss whether their successful experience on developing knowledge industries still support the hypotheses of key success factors put forward in the Diamond Model. The result of case studies will provide useful evidence to formulate an analysis framework for the knowledge industry development.

Case 1. Hangzhou, Zhejiang province (Development of the electronic information industry)

Hangzhou is the capital city of Zhejiang province, eastern of China. It is known as "*Paradise of Silicon Valley of China*" for its success in the electronic information industry. From 1980s, the trend that the electronic information industries transferred gradually to Asia-Pacific area has brought many opportunities to China. Since then, Hangzhou government began to actively support and promote the development of scientific research institutions related to the electronic information industry. In addition, local enterprises were also encouraged by the government to engage in the electronic manufacturing industry through introducing foreign advanced technologies and independent innovations. As a result, a brilliant electronic manufacturing industry is formed and the products widely covered from communication equipments, software to microelectronics, optical fiber and so on. Up to now, Its R&D and production capability accumulated had reached the advanced level in many areas, especially in the fields of integrated circuit designs and semiconductor materials.

When entering into the mid 1990s, an expansion from hardware to software in the electronic information industry was occurred globally, and then digital and intelligent technologies became a new driving force for the industry's upgrading and diversification. The combination between the electronic technologies and the traditional industries has created new wider industrial markets. Hangzhou government noticed this change and consequently started to seek and encourage the diversified development trend based on its industrial competitiveness acquired in the past. Many relative industries, such as digital TV, network services, and other new industries emerged subsequently.

During these years, the electronic information industry has become a fundamental and leading industry of Hangzhou city. According to a statistics, Hangzhou has assembled 1/3 of internet firms and 2/3 of the trading on

E-commerce of China. At present, an industrial cluster named as "6+1" that contains communication, software, integrated circuit (IC)design, digital TV, cyber game, E-commerce and internet service has formed in the city. Many glorious reputations, such as "*Capital City of E-commerce of China*", "*National Base of Electronic Information Industry*", "*National Base of Software Industry*" and "*National Integrated Circuit Design and Industrialization Base*", are awarded to the city for its great achievements in the electronic information industry.

Case 2. Hefei, Anhui province (Development of the new energy auto industry)

Hefei is the capital city of Anhui Province, central region of China. Around 2005, the municipal government determined that the city will focus on eight pillar industries in future that include new LED industry, new energy auto industry, advanced material industry and other five kinds of knowledge-based industries. Among them, it is noticeable that the success of new energy auto industry is becoming a typical case at present. The city's successful practices can be summarized into three aspects:

Practice 1. The government launched many special policies to meet the demand of new energy auto industry, such as "*The plan for demonstration and popularization of new energy auto*" in 2010, "*Some suggestions for enhancing the popularization of new energy auto*" in 2012, etc. Such policies clearly encourage important internal and external auto enterprises to form a strategic alliance of new energy automobile industry aiming to enhance R&D and manufacturing collaboration. In addition, some financial supporting programs and social promotion plans also included in these polices.

Practice 2. Establishing two related research institutes to from a joint technical R&D group. One is *Hefei New Energy Automobile Research Institute*, which is initiated by Hefei University of Technology, Jianghuai Auto Group, JEE Automation Equipment Company and other supporting organizations. The other one is "The Strategy Alliance of Auto Manufacturers". The alliance is composed of 25 companies and investment organizations and widely covered the production of auto battery, electric machine, electric control and other key products related to new energy auto. In other words, this alliance has created an integrated coordination system for all members to participate in the whole industrial activities from design, manufacture to operation and service. Obviously, it is highly critical for the rapid growth and the quality control of new energy automobiles.

Practice 3. Positively production encouragement and sale promotion. The urban government has purposely supported the industry expansion by firstly purchasing and applying the new autos in public areas such as public transportation, public sanitation, postal service, etc. More importantly, some promotion plans aiming at stimulating social purchase were carried out continuously. For example, if a citizen buys a new energy vehicle, he will receive provincial and municipal subsidy, which is as high as RMB 20,000 for each mixed energy car and RMB 80,000 for each pure electricity-driven car. In addition, some more new promotion plans are made to enable more citizens to fully realize the advantages of new energy vehicle, such as planning to build an experiential center of new energy auto for the citizen in the end of 2012 and to construct more convenient charging facilities for electricity-driven autos through special funds. Consequently, these measures above greatly expanded social demand for new energy autos as well as production scale of manufacturers.

Up to now, Hefei has gained a highly visible success in the new energy auto industry. The pure electric vehicles (The third generation of new energy autos) already have been produced successfully and be fashionable in other areas of China just now. An official statistics shows that, up to September of 2012, Hefei has ranked the forefront of Chinese provincial cities in the promotion of energy-saving vehicles and got the first place in the sale of pure electric autos.

Case 3. Chengdu, Sichuan Province (Development of the Bio-medicine industry)

Currently, as a typical knowledge intensive industry, the bio-medicine industry is becoming one of high-tech industries in the world. In 2010, Chinese government has planned this industry as China's top priority in next five years' industry planning. The success of Chengdu, a capital city of Sichuan Province in western of China, is a right case for the research. In general, its success also originated from three practices:

Practice 1. Local government focused on the formulation of clear strategy planning and relevant policies to promote the industry's growth. Early in 2008, "*The Plan for Bio-medicine Industry Development (2009-2012)*" was issued actively by Chengdu government aiming to support the development of bio-medicine industry. In October of 2012, the municipal authorities put forward again a more long-term strategic planning for bio-medicine industry that includes two main tasks: one is to build five major special areas separately for the development of biological pharmaceutical, biomedical material and medical equipment, modern Chinese medicine technology, chemical synthetic medicine and biomedicine trade service. The other is to regulate the industry distribution for each urban district by the principle of "different district, different industry focus" in order to formulate three concentrated zones for bio-medicine operation, manufacturing and technological R&D. For instance, High-tech Zone of Chendu is mainly for significant R&D of biological technology; Jinjiang District is for the development of the vaccine industry. Jiangyan and Qionglai Districts focus on modern Chinese medicine industry; Jinniu and Xindu Districts are arranged for the development of biological medicine trade and some other Districts focus on herbs planting and processing.

Practice 2. Building competitive centers for biomedical R&D, industrial incubation and medicine trade to create a geographic structure named "one center and two zones" based on Tianhe Incubator Center and Tianfu Life Science Zone. On the one hand, high qualified public services including necessary financial fund and land are offered by the urban government to support the local enterprises in knowledge innovation and technology research. On the other hand, positively encouraging global enterprises to come into the special zones has received good effect partly because complete services including financing, R&D platform, property transaction, product display and international cooperation can be provided in these zones.

Practice 3. Formulation and operation of internationalization strategy has played a positive role in the development of bio-medicine industry, which can be indicated from two main facts: one is strengthening international technology cooperation. For instance, since 2008, Chengdu has successfully carried out multi-level cooperation in the biomedical field with many foreign firms from more than 60 countries including America, Germany, Switzerland, France and others. The other is creating more chances to attract foreign investments, talents and international trades for local enterprises through high-level conferences and fairs, such as "*International Science and Technology Conference on the Modernization of Chinese Medicine*" host regularly from 2002.

According to "*The 12th Five-year Plan for Chengdu's Strategic Emerging Industry Development*" published in October of 2012, By 2015, the main business income of Chengdu's biological industry will reach 60 billion RMB, with an average annual growth rate of 20%. It is believed that the new planning will bring more resources for biological medicine industry in future.

Case 4. Tianjin, China (Development of the Aviation &Aerospace industry)

As an important industrial city in north of China, Tianjin is adjacent to Beijing city and Bohai Harbor. In the development of knowledge industries, although the city has made outstanding achievements in many industries, such as new energy, new material, electronic information and others, the rapid development of aerospace industry has aroused more attention at home and abroad. According to a statistics, Tianjin's aerospace industry has developed with an annual rate of 180% growth on average since the operation of "*The National Airbus A320 Assembly Project*" in 2006. Obviously, Tianjin's remarkable success in the aerospace industry is also quite worthy of studying.

As a knowledge-intensive and high-tech manufacturing industry, what factors contribute to the aerospace industry's success of Tianjin? Many domestic scholars emphasize that the unique advantages of Tianjin, such as excellent location, abundant capital and qualified talents, have played an important role in the industry success, but we consider that some development opportunities are also critical. Actually, around 2006, two important national aerospace projects named "*The National Airbus A320 Assembly Project*" and "*The New Generation of Big Thrust Rocket program*" successfully operated in Binhai Hi-tech Zone of Tianjin, A good chance is produced consequently for the city to enhance the growth of aviation & aerospace industry.

In order to support the implementation of these significant projects, the city immediately planned aerospace industry as an urban dominant industry in future and thus formulated several detailed development plans for it. The plans included clearly establishing KongGang Economic Zone and Binhai Hi-tech Industrial Zone for the aerospace industry development. In addition, positive encouragement with the purpose of attracting more overseas investment has played a critical role in accelerating the agglomeration of supporting industries in these special zones. As we know, more than one hundred domestic or foreign aerospace enterprises related have settled into Tianjin during these years, such as FTG of Canada, An leading manufacturer for aerospace electronic product; EUROCOPTER, a famous helicopter manufacturer with many excellent businesses on aerospace assembly and modification; Xi'an Aircraft Industrial Corporation of China, Goodrich, Thales, Etc. A complete industrial chain that includes different departments of design, R&D, testing, component producing, assembly, marketing, technological repair and others is fully formed in Tianjin.

For the aerospace industry, it also benefited from a good opportunity, which is the starting of "*The New Generation of Big Thrust Rocket Program*" in Tianjin in 2007. During the next few years from then, a number of other aerospace projects, such as CNAC Helicopter UAV, Long March Rocket, Satellite Communication, have continuously gathered into Tianjin to seek new collaborations. Meanwhile, a large number of famous research institutes or related enterprises, such as China Academy of Space Technology, China Academy of Launch Vehicle Technology, China Civil Aviation Base of Industrialization of Science and Technology, Aeronautics and Astronautics Industry Institute of Tianjin University, were founded in the city to participate in a wide range of fields including space power project, lunar exploration program, the second generation of large aircraft navigation and other aerospace programs. At present, the aerospace industry agglomeration is accelerating in the city and a wide integrated industry cluster covering air transportation, air logistics, aviation training, aerospace exhibition and other businesses is basically established in the city. It is obvious that the cooperation among the urban government, the enterprises and different kinds of research institutions is enhancing the city towards an important aerospace industry base in China.

According to "*The 12th Five-Year Plan (2011-2015)*" released by the urban government in 2011, the urban

government will focus on the infrastructure construction and supporting the growth of related industries with the purpose of introducing more aerospace projects from the outside. Up to 2011, the whole production value of this industry in Tianjin has achieved 22.77 billion RMB and the industry scale has ranked the fourth of China. It is predicted that the gross production value will reach 100 billion RMB in 2015 and the success of aerospace industry will bring new glory for the modern city.

Case 5. Shenzhen, Guangdong Province (Development of the culture industry)

Shenzhen city, as known as "The Window of Chinese Reform", is located in Guangdong province of southern China. With 30 years of rapid economic growth, Shenzhen has successfully transformed from a poor town into a world famous modern metropolis today. Although the city didn't have profound cultural, excellent cultural talents and cultural institutions traditionally, Shenzhen has made much progress in the culture industry. Many domestic scholars are fascinated by its success in the cultural industry with different explanations. Among them, the high demand and the effective encouragement by the local government are always considered as the critical reasons for its success.

From the demand perspective, it is noticeable that Shenzhen has accumulated abundant capital, advanced technological advantages during many years' development in traditional manufacturing industries, especially in the fields of electronic technology and information technology. From 1990s, the great social demand for high-tech cultural products in domestic and foreign markets aroused widespread innovation activities in the culture industries. Consequently, the combination between digital technologies and traditional culture industries produced several new high-tech culture industries for Shenzhen. For instances, some local enterprises in the traditional printing industry and the handicraft manufacturing industry rapidly acquired new competitive advantages when these industries are recombined by the application of high-technologies successfully. The integration between the technologies of communication, electronics, information and the traditional media industry also formed more colorful animation industries as well as some studio entertainment industries. Based on the booming of high-tech culture industries, Shenzhen again opened up a new cultural tourism industry through the new integration between the tourism industry and the culture industry around 2005. For example, Shenzhen has created many famous bases for cultural tourism such as the first culture park of China, Folk Culture Village, The Window of the World, Happy Valley, Dafen Oil Painting Village, etc. As a result, this attempt successfully expanded the industrial value of the culture industry. In 2008, Shenzhen was therefore awarded "City of Design" by *UNESCO's Creative Cities Network* as for its successful culture innovation.

From the urban government perspective, three main aspects should be mentioned for Shenzhen's success in the culture industry. The first is the clear policy formulated by the urban government: Shenzhen firstly proposed "The Culture City Strategy" with a series of effective policies in 2003, and promulgated the first local law promoting the culture industry in 2009. Especially, the proposal of "*Some Economic Policies for Developing the Culture Industry*" made in 2005 has put forward several detailed incentive measures for the culture industry development including 3 years of tax-exemption for new culture enterprises aiming at promoting the industries of cyber game, the creative design, the modern art, etc. Secondly, the city established a special fund of 500 million RMB every year to assist a large number of culture enterprises in high speed of growth and the implementation of many creative culture projects. It is reported that Shenzhen government has sponsored 346 projects with the subsidy of 312 million RMB from 2008 to 2011. Lastly, the hosting of "*China (Shenzhen) International Cultural Industries Fair*" each year from 2004 as well as "*The First China (Shenzhen) Design Exhibition*" in December of 2012 are highly useful for the city to utilize more excellent cultural achievements and resources in the other areas of China and to strengthen the international influence of its culture industry.

Around 2008, Shenzhen launched a more significant urban strategy that is "Knowledge-based Urban Strategy". Obviously, the new strategy has significantly focused on the culture industry's growth in Shenzhen. As a result, a giant industry cluster that covers creativeness design, digital animation, cyber game, electronic publishing, high-tech art and other industries is consequently formed in the city. Up to now, it is reported that the added production value in the culture industry of Shenzhen has amounted to 77.56 billion RMB annually, as 6.74% of the city's GDP. What is more, Shenzhen is also an important national culture exporting base as its exportation highly occupies 20% of the whole nation. Therefore, it is quite understandable that Shenzhen was awarded "*The Outstanding Developing Knowledge City*" in the Second World Summit of Knowledge City in 2009 as for its success in the knowledge-based development.

3. KEY FACTORS ANALYSIS AND RESULTS: SUPPORT TO HYPOTHESES OF THE DIAMOND MODEL

In this section, we will examine whether the cities' success above still support the six key factor hypotheses proposed in the Diamond Model and in what way. For this purpose, one table is provided for each city (see Table 1-Table 5) and an integrated table is displayed in the Table 6. The factor hypotheses are in the first column of each table. Sub key factors analysis is demonstrated in the second column. The support level is in the last column including

three levels: high (H), medium (M) and low (L). For the sake of simplicity, each factor is replaced by F1-F6: F1, Factor conditions; F2, Demand conditions; F3, Related and supporting industries; F4, Firm strategy, structure and rivalry; F5, Government; F6, Chance.

Table 1
Development of the Electronic Information Industry (Hangzhou City)

Factor	Sub key factors analysis	Support level
F1	●Intellectual resource: Hangzhou city has lots of well-known universities and experienced research institutions that are specialized in the field of electronic information. ●Technical advantage: The city owns many core electronic technologies. Besides, different types of collaboration between local enterprises and international firms provide useful conditions for technology innovation. ●Capital resource: Private economy is very active in the city and much accessible private capital is invested into electronic information industry. According to statistics, the proportion of private enterprises in this industry in Hangzhou has achieved more than 90% up to now. ●Industrial basis: The city has modern industrial service system such as the transportations, super geographical position and strong innovation urban culture. According to the World Bank (2006), Hangzhou is the best city for investment in china.	H
F2	Driven by the favorable turn of the electronic information industry globally in 2010, the huge demand for applied software grows very fast especially in the fields of finance, public security monitoring, information service, etc.	H
F3	●Many R&D branches of transnational corporations settled in Hangzhou city, such as R&D center of NOKIA, software R&D center of SIEMENS, semiconductor R&D center of SAMSUNG. These firms could provide much technological support to urban information industry development. ●Oriented by "Digital City Strategy", an industrial integration between the ICT and the computer technology in Hangzhou successfully stimulated the thriving of related and supporting industries.	M
F4	●Massive investment and mutual competition among multinational corporations became an important driving force for the rapid growth of the electronic information industry. ●In the electronic information industry, A good competition structure is created by many competitive as well as high innovative enterprises existed in the city, such as Zhejiang Supcon Group, Alibaba Group and Insigma Technology Co., Ltd., etc.	H
F5	●Making special strategy and supporting policies, e.g. "*Three years action plan for the restructuring and revitalization in electronic information industry*" made in 2009, "*The twelfth Five-Year Plan (2011-2015) for Hangzhou's informatization*" proposed in 2011, etc. ●Providing lots of incentive measures to attract more investments into the software and IC industries and establishing special funds to assist related R&D activities. ●Building 21 development zones for the high-tech industries aiming to create a friendly urban innovation atmosphere. For instance, four precincts (Eastern, Western, Southern and Northern zone) are built for the software industry development. ●Holding international transaction and exposition for the cooperation globally, such as "*Electronic Information Expo of China*".	H
F6	The electronic information industry has transferred gradually to Asia Pacific area from 1980s, which produced many chances for Hangzhou city.	M

Table 2
Development of the New Energy Auto Industry (Hefei City)

Factor	Sub key factors analysis	Support level
F1	●Intellectual resource: The technology innovation alliance for the new energy automobiles, which consists of 24 enterprises, three excellent universities, two research institutes and three government departments, formed an essential basis for the industry. ●Technical advantage: Automobile industry is a pillar industry of Hefei traditionally. Several well-known automobile enterprises have many years of experience in the vehicle R&D and manufacturing and possess some core technologies related to the energy-saving autos. ●Capital resource: Strong investment is sponsored by the urban government and local enterprises, e.g. Ankai Auto Company has spent 500 million RMB on the construction of the energy-saving auto R&D and production base. Chinese Government also arranged special funds to construct battery charging facilities in Hefei.	H
F2	●The energy shortage and Chinese government's ongoing environmental protection are arousing new surging demands for energy-saving autos. A good evidence is that Chinese government has offered an special subsidies amounting to 12 billion RMB for energy-saving vehicles early in 2010. ●According to *The 12th Five-year Plan for Chinese Auto Industry*, enhancing the growth of new energy vehicle industry is set as the government's priority in the next five years and the total sale of pure electric vehicles and plug-in hybrid vehicles expected will reach 500,000 Yuan in 2015 and more than 5 million Yuan in 2020, according to China Association for Automobile Manufacturers.	H

Continued

Factor	Sub key factors analysis	Support level
F3	●Hefei has perfect automobile accessory industries because it has nearly 50 years' history of the auto production. ●In the critical areas of the electricity-driven auto, 25 supporting firms and investment institutions with a wide rang of products including high-capacity battery, electric machine and electric control system, has formed an industrial alliance in Hefei. ●Regarding other supporting services, Hefei has a perfect "6S" service system, including battery charging, battery renewal service, sale assistance, repair supports and other services.	H
F4	Effective competition is formed among large-scale enterprises in the city, such as Jianghuai Auto Group, Chery Group, Ankai auto Co., Ltd. etc.	M
F5	●launched supporting policies, such as "*The plan for demonstration and popularization of new energy auto*" in 2010, "*Accelerating the Charging Pile Construction for New Energy Vehicle*" in 2012, etc. ●established financial funds for the auto R&D, new auto manufacturing, charging station construction, social application and other fields related.	H
F6	In 2009, Hefei was identified as one of the first batch of national experimental cities for energy-saving vehicles promotion.	H

Table 3
Development of the Bio-medicine Industry (Chengdu City)

Factor	Sub key factors analysis	Support level
F1	●Herb resource: The number of Chengdu's herbal species occupies nearly about 50 percent of the total amount of Sichuan province, which is also the richest province in China with regard to Chinese medicine resources. ●Intellectual resource: The number of medical practitioners in Chengdu has reached 52,000 early in 2008. There are 64 professional medicine colleges or research institutes, 7 national or provincial laboratories and 12 national or provincial engineering (Technology Research) centers in the city. ●Technical advantage: Local enterprises hold many advanced technologies or technical patents in the fields of protein biopharmaceutical, vaccine, electronic medical equipment, etc.	H
F2	●The medical reform of China is enhancing the people's medical payment ability with more than 100 billion RMB. Obviously, the added ability will increase the demand for biological medicines consequently. In the next five years, the demand for medicines is expected to grow as a rate of 15% to 20% annually, according to an official report. ●In global pharmaceutical market, the total scale is expected to reach 1100 billion dollars in 2014, which will provide a huge space for the biological medicine industry development.	M
F3	●As the national industrial base of Chinese medicine, the city has a complete industrial chain of medicine ranging from the starting-phase innovation to clinic R&D, from modern manufacturing to medicine trade service, from herb planting to drug processing. ●Chengdu is a "Well-known Software City of China" and its developed electronic information industry has played an important supporting role in the thriving of bio-medicine industry by the supply of relevant technology.	H
F4	●Up to September of 2012, Chengdu city, with more than 600 biomedical firms, has got the first place in the Western China and the third in the whole nation, only behind to Beijing and Shanghai. ●Several traditional medicine enterprises have competitiveness especially in the fields of medical equipment and vaccine research. ●In 2009, Chengdu Biology and Medical Industry Incubator Company, Chengdu Di'ao Group and other twelve enterprises composed an industry innovation alliance. This joint alliance is promoted by urban government with the purpose of strengthening technical cooperation among the member firms, formulating technical standards or rules and effectively reducing internal transaction cost and R&D risk.	H
F5	●Formulating related strategies to direct the bio-medicine industry development, such as "*The 12th Five-year Plan for Chengdu's Strategic Emerging Industry Development*" released in October, 2012. ●Building three concentrated zones separately for bio-medicine operation, bio-medicine manufacturing and R&D by the principle of "Different District, Different Industrial Focus". ●Providing necessary support including capital, talent and service for the special development zones.	M
F6	The bio-medicine industry has planned as China's top priority in next five years in 2010.	L

Table 4
Development of the Aviation & Aerospace Industry (Tianjin City)

Factor	Sub key factors analysis	Support level
F1	●Industrial basis: Tianjin owns a prefect international transportation system and information and communication network; In addition, the city is rich in oil, natural gas, sea and land that are very fundamental for the aerospace industry development. ●Technical advantage: Plenty of famous research institutions and enterprises were founded in Tianjin with many different technical businesses, such as China Academy of space technology, China Academy of Launch Vehicle Technology, Aeronautics and Astronautics Industry Institute of Tianjin University, etc. ●Capital resource: Besides the investment from many large-scale enterprises and urban government, a large amount of venture capital is available in its developed financial market. For instance, the first domestic fund for the aerospace industry amounting to 20 billion Yuan was set up in Tianjin city.	M
F2	●With the deregulation of low airspace in China, the strong social demand of aviation products is expanding quickly. It is expected that the need amount of civil transportation airplanes, ordinary aircrafts and helicopters in China will reach 1,900 to 10,000 in the next 20 years. ●The gross production value of Tianjin's aerospace industry may achieve 100 billion RMB in 2015, which is derived from the strong need from the domestic and foreign markets.	H
F3	●External supports: As the national advanced manufacturing area, Binhai High-tech Zone where the aerospace industry located has nine functional areas separately for the development of various industries including finance, trade, shipping, electronic information, logistics, equipment manufacturing, new energy, new materials and others. Thus, the aerospace industry can receive full external support provided by these industries. ●Internal supports: Followed by some significant national projects, many high qualified supporting firms swarmed to Tianjin afterward. According to statistics, nearly about 50 large-scale supporting enterprises have gathered towards Tianjin with the supply of different service. More important, many more famous corporations are gathering into the city.	H
F4	●Many first-class aviation enterprises in the global are actively seeking new markets in Asian in recent years, and Tianjin's comparative advantages and several national aerospace projects operated in the city are highly attractive for these firms to settle into the city. Consequently, an effective competition and cooperation structure is formed in the related industries.	H
F5	●Setting up some special zones for the aerospace industry development and formulating an broad industrial system as called "Three Aircrafts, One Rocket, One Satellite, One Aerospace Station". ●Introducing a lot of world-famous enterprises to invest in Tianjin and provide necessary funds, public services and other supports for them, such as establishing a special fund for the aviation R&D programs and manufacturing expansion. ●Creating favorable innovation environment for local firms' technology innovation through introducing high-tech R&D projects, encouraging large enterprises to set up R&D bases in Tianjin, etc. ●Providing considerable opportunities of technical exchange, cooperation and transaction for the local enterprises, such as hosting "2012 Tianjin International Aerospace Summit & Aerospace Products Exhibition".	M
F6	●As a National Experimental Area, Binhai High-tech District of Tianjin was set up for advanced manufacturing with lots of offers. ●Several national significant aerospace projects such as "National Airbus A320 Assembly" is settled into Tianjin.	H

Table 5
Development of the Culture Industry (Shenzhen City)

Factor	Sub key factors analysis	Support level
F1	●Capital resource: Abundant capital is available including different types of financing, private investment, special funds from the urban government. ●Culture atmosphere: The civil culture of Shenzhen is characterized as openness, tolerance and pluralism and the core business culture is collaboration and competition. This culture atmosphere provides a good environment for so many creative culture activities of the city. ●Technical advantage: Shenzhen is excellent in the electronic information technologies that are critical for the high-tech culture industry development.	M

To be continued

Continued

Factor	Sub key factors analysis	Support level
F2	●Massive advanced manufacturing industries in Shenzhen have great demand of high-tech designs supported by the culture industry. ●With the development of internet and new medias, the consumption for high-tech culture products is enhancing the growth of culture industry.	H
F3	As the birthplace of Chinese modern graphic design and as an important national information industry base, Shenzhen has competitive advantage in many fields including industrial design, interior design, electronic information, software service, etc. Many high-tech culture industries, such as digital television, digital music and others, can acquire important technological support from these traditional industries.	H
F4	●Some excellent culture firms emerged from the local fierce competition. For example, Creator of High Quality Life Group and Fantawild Holdings Inc. are as known as two largest culture and technology companies in Shenzhen. They are competing with each other at a wide range of businesses: creative design, cultural tourism, new media, digital entrainment, etc.	M
F5	●Shenzhen proposed "Culture City Strategy" and "Knowledge City Strategy" firstly in China, which are clear guidelines for the growth of culture industry. ●A lot of policies and actions are fulfilled to promote the culture industry development effectively. ●Holding many influential related fairs or exhibitions to attract more capitals, projects, technologies, talents and transactions for the industry. ●Building different zones to accelerate the industry agglomeration. ●Setting up special funds for the development of cultural industry.	H
F6	The industry transition from "Made in China" to "Innovation in China" has produced enormous opportunities for the culture industry.	M

As Table 6 shown, the results of their practical experiences above indicated that the Diamond Model can explain the key factors for each city's success in different knowledge industries very well. In other word, the key factor hypotheses are successfully supported by the cities' experience with high supporting levels.

Table 6
Total Analysis Results (Support level)

Factor	Hangzhou	Hefei	Chengdu	Tianjin	Shenzhen
Factor conditions	H	H	H	M	M
Demand conditions	H	H	M	H	H
Related and supporting industries	M	H	H	H	H
Firm strategy structure and rivalry	H	M	H	H	M
Government	H	H	M	M	H
Chance	M	H	L	H	M

4. AN INTEGRATED ANALYSIS MODEL FOR KNOWLEDGE-BASED INDUSTRY DEVELOPMENT

Based on the above conclusions and our previous works on these cities' industry histories, we will attempt to establish an integrated analysis framework for knowledge industry development in this section. As depicted in Figure 2, the proposed framework consists of five phases:
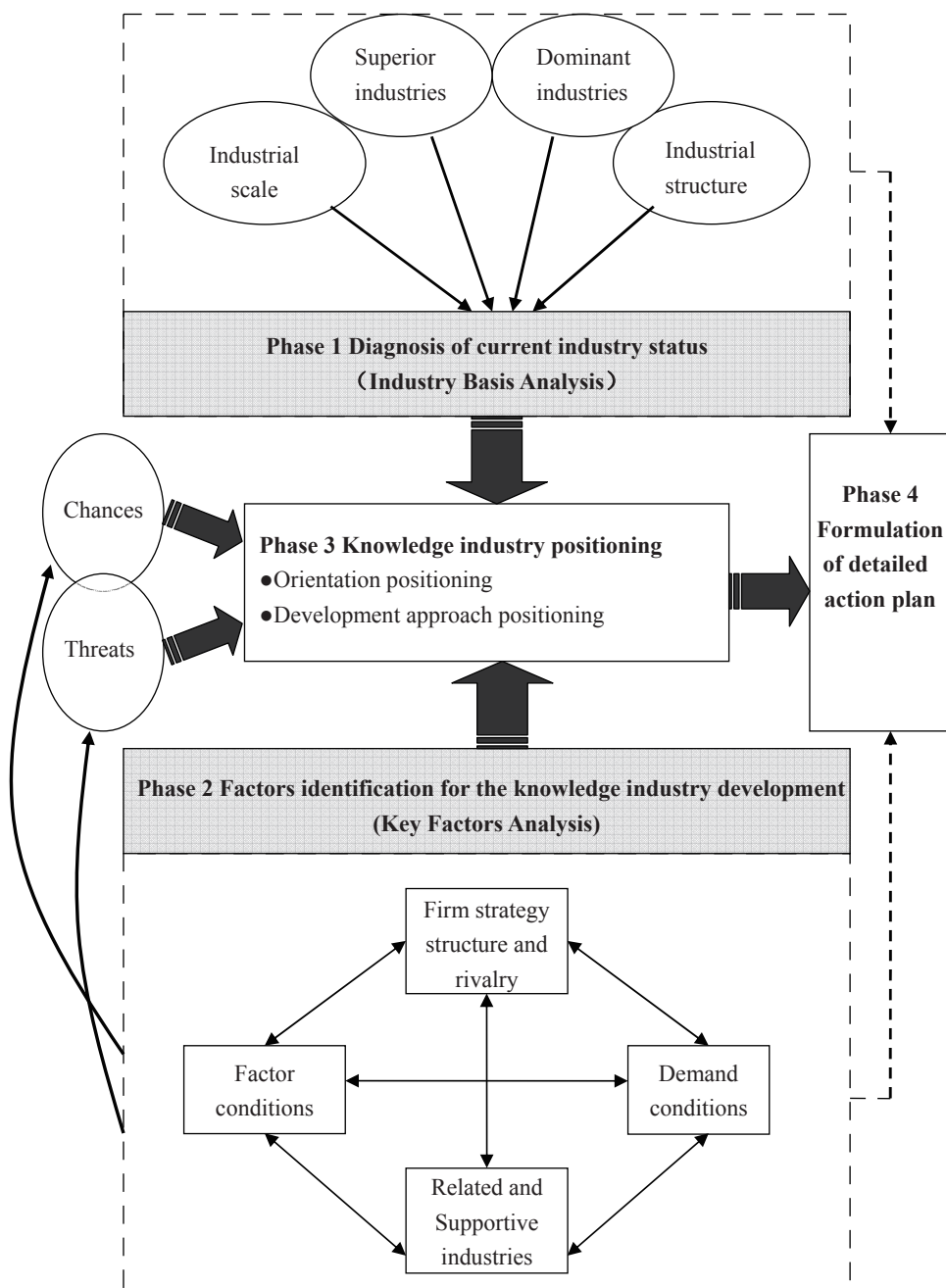
Figure 2
A Proposed Analysis Model for Knowledge-based Industry Development

Phase 1: Diagnosis of current industry status

The cases studies show that the development of knowledge industries in a city is always evolved from its traditional industries through industry upgrading or industry transition. For example, Shenzhen has many traditional advantages in the electronic information industry, which has provided much important technical support for its culture industry development. Therefore, a city with a good industrial foundation, especially with many advantages in the traditional dominant industries, can easily acquire success in the knowledge industry development. Thus, the first step for any city that attempts to develop knowledge industry is to diagnose its current industry status because the development of knowledge industries greatly depends on a city's initial industrial basis. What should be taken into the diagnosis? We consider that four main aspects should be analyzed properly. They are: total industry scale, industry structure, advantageous industries and dominant industries. The diagnosis purpose in this stage is to put forward several possible assumptions of knowledge industries that may be developed in the city from its industry basis perspective.

In addition, a city's legacy of declining industries should also not be ignored by the urban government in this stage because the legacy level (high, medium or low) will lead to many complexity and difficulties in the knowledge industry development, such as relatively high unemployment rates, a high percentage of people on benefits, a low-educated population and a low score on quality of life, etc. (Van Winden, van den Berg, & Pol, 2007).

Phase 2: Factors identification of knowledge industry development.

In the previous stage, a right development assumption of knowledge industries can be put forward based on a city's current industry status. However, the development of an emerging industry depends not only on the city's existing industrial status, but also on the city's industrial factors for the growth of the new industry. The case studies have shown that six factors mentioned in Diamond Model including factor conditions, demand conditions, firm strategy structure and rivalry, related and supporting industries, government and chance are critical for these cities' success in various knowledge industries. Thus, the purpose of this stage is to consider and formulate a new assumption of knowledge industries by the analysis of a

city's core capacities and advantageous resources from the perspective of six critical factors as concerned. Because the role of the government is subjective and is difficult to be defined, so the analysis in this step will focus on the remaining five factors and the threat, a new added factor proposed by us. In order to facilitate the research, we firstly divide the six factors into two groups: the internal as well as inevitable factor group (contains the four key factors in figure 1 except the government factor and the chance factor) and the external as well as accidental factor group (contains the chance and the threat). As shown in table 7, the internal factors analysis aims to evaluate a city's strengths and weaknesses concerning the four factors and their subfields. The internal factors analysis aims to identify a city's all possible opportunities and threats that may affect the growth of the internal factors above.

◆**Analysis of strengths and weaknesses**

On the basis of our case study findings, an analysis method and the key analysis points (i.e. the indicators related) for each factor's strengths and weaknesses are shown in Table 7. Each suggested indicator should be identified and analyzed from two aspects: strengths and weaknesses.

Table 7
Analysis of Strengths and Weaknesses Related to Four Factors

Factors	Factor explanation	Key points of analysis (strengths and weaknesses)
Factor condition	It contains fundamental factors and input factors. Fundamental factors indicate a city's physical basis including urban transportation system, natural environment, financial market, logistics system, etc. Input factors are directly relevant to the knowledge-based industry growth including a city's technical achievements, qualified talents, R&D capabilities and advantages, capital, etc.	(a) Urban infrastructure status; (b) Urban human resource level (namely knowledge density); (c) Competitive technologies and industrial areas covered; (d) Degree of Capital abundance, including venture capitals.
Demand condition	Great demand of knowledge-intensive products in home and outside market is essential for sustainable innovation of local knowledge-based enterprises. For example, the rapid progress of culture industry in Shenzhen has much to do with fierce pursuit of high-tech cultural products among the native consumers.	(a) Knowledge-intensive product demand in the local, domestic and international markets. (b) Purchasing power of internal and external consumers. (c) The unexploited markets and potential demands related.
Related and supporting industries	The status of complementary industries and supporting industries related to the knowledge based industries. The growth of knowledge industries more depends on wide knowledge innovation and knowledge diffusion among different complementary and supporting entities.	(a) The integrity level, quantity, quality and competitive strengths of supporting industries. (b) The integrity level, quantity, quality and competitive strengths of complementary industries.
Firm strategy structure and rivalry	Effective competition among local enterprises can enhance the activities of knowledge creation and technology innovation. Thus, the urban government should focus on an open, free and fair competition environment construction for the knowledge industries through many ways such as industry cultivation (e.g. Introduction of external competitors), industrial structure adjustment industry recombination (including the acquisition merger in local industries) and so on.	(a) Quantity of knowledge-based firms. (b) R&D level of local enterprise; (c) The main innovation trends of local enterprises including future strategy, industry preference and innovation focuses.

Through the analysis above, we can clearly describe a city's status including its current advantages and disadvantages in four key factors which are essential for the

success of knowledge industry development. More important, the analysis results can provide an obvious guideline on the factors development for the knowledge-based industries.

◆**Analysis of opportunities and threats**

Opportunities and threats are the accidental factors. Many kinds of opportunities, including world-class events, new national urban planning, arrival of significant national projects, setting up of high performed universities and research organizations, may bring considerable new resources (as capitals, talents, advanced technologies, etc.) and economic priority for the city. In other word, these new opportunities might create explicit focus and vision for tomorrow's knowledge industries rather than the policy group of present industries. The threats, as accidental as the opportunities, are considered the different kinds of risk, such as inability to retain high-quality human capital, the increasingly serious pollution and others.

It is no doubt that the opportunities and the threats will perform actually by the influence they imposed on the four key factors as mentioned, no matter the influence is positive or negative, thus, the analysis of opportunities and threats should also be carried out from the four factors (as shown in Figure 3).
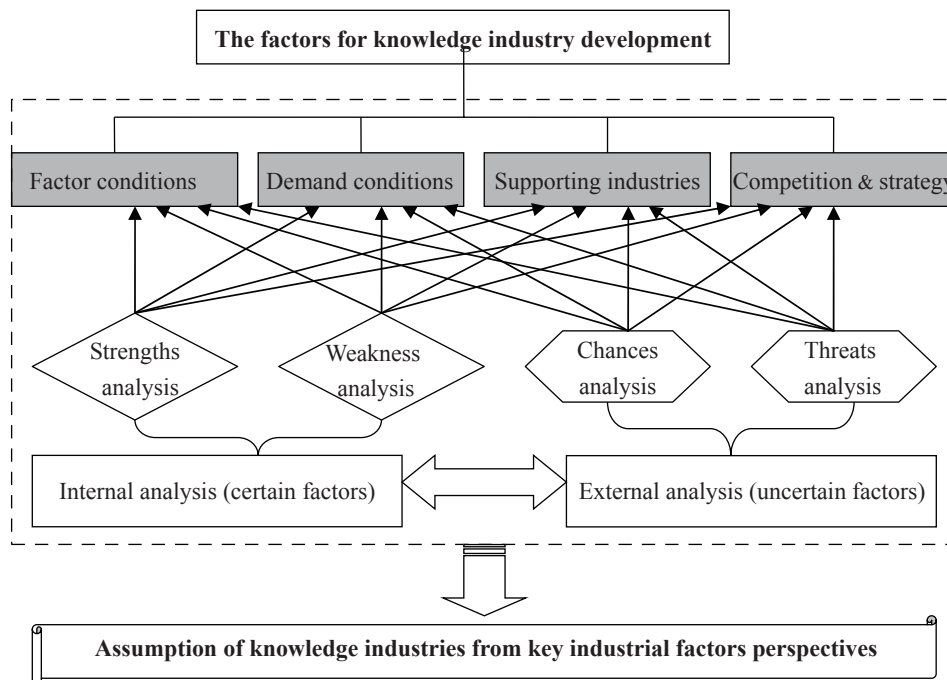

Figure 3
Factor Identification of Knowledge Industry Development

From the two aspects analysis in this step, we can mainly identify a city's advantages, disadvantages, opportunities and threats in four factors that are critical for knowledge-based industries. Consequently, a new assumption of knowledge industries from its resource & capability perspective can be formulated basically. However, it is easily found that this new assumption is different from the formulation of knowledge industries proposed in phase 1 because the two assumptions are separately derived from a city's current industry status analysis and key factors analysis. Therefore, it is necessary to make a comprehensive analysis by comparing and discussing the two conclusions in order to make an explicit decision on two fundamental issues: what knowledge industries a city should focus on finally and how to develop. The answer for these questions will be discussed in phase 3.

Phase 3: Knowledge industry positioning

After the first two stages analysis, a city's industrial basis and the advantages of key factors for the knowledge industry development can be defined clearly. Through a combinative analysis of the two aspects, we can get different types of combinations. If each analysis result has two possibilities: weak and strong, and then we can divide the different combinations into four types (as shown in Figure 4). Obviously, when we identify which kind of combination a city belongs to. A core problem followed is how to design a best approach to develop the knowledge industries. With the conclusions of cases studies, we attempt to discuss different approaches base on different combinations in this section.
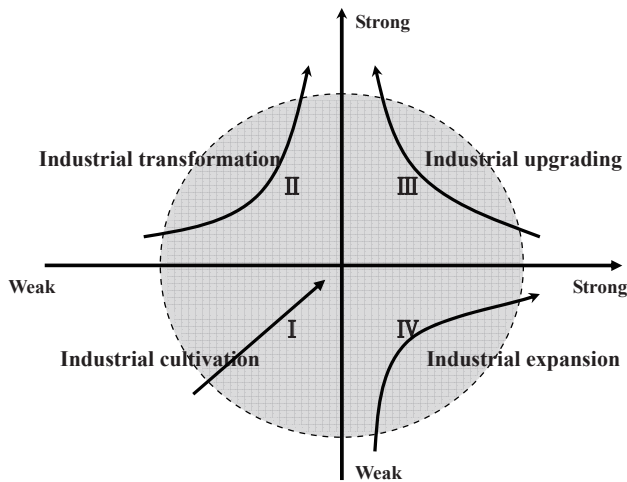
Figure 4
Four Development Approaches for Different Combinations

Horizontal axis: Advantages of traditional industries (current industrial basis); Longitudinal axis: Advantages of key factors for knowledge industry development.

●**Pattern I:** In this type, the city i**s** lack of advantages both in traditional industries and in the critical factors for knowledge industry development. In this situation, the city hall may face the most difficult in the knowledge industry development because the city has no signs of knowledge industry and its traditional industries don't have powerful economic capability to support the industry reform towards the knowledge industries. Frankly speaking, the city doesn't have the conditions for the knowledge-based development. Thus, the urban authorities may need to rethink profoundly its potential resources and external undiscovered opportunities aiming to restructure its traditional industries and to purposely support several existing industries with bright future. Therefore, as shown in figure 4, the track of its possible development is a movement from the outer circle towards the central point. More wealth and resources will be accumulated for the future development of knowledge-based industries in this way, which is proved perfectly in some resource-exhausted cities of China and others regions.

●**Pattern II:** The city is losing its advantages in the traditional industries, but the factors accumulated for the knowledge industry development are relatively high. That is to say, the city is just at the turnaround of industrial transition from traditional industries to knowledge-intensive industries. In this context, the urban authorities should consciously formulate special strategy and plan for new knowledge industries development. Especially for the unsustainable traditional industries, it is advisable to seek alternative knowledge industries in order to effectively utilize urban knowledge resources accumulated for a long time (Creative achievements, talents, technology advantages, etc.) as well as all possible external resources. The municipals should initiate the industry transition

in the declining industries by clear urban policies and incentive measures, such as special funds for knowledge and skill training with a purpose of providing more knowledge workers for the new industries. In addition, the local government need completely assess its weaknesses for the knowledge industry development from the prospective of industrial chain and four key factors as concerned. Especially, the status of complementary industries and supporting industries should not be ignored by the authorities because the growth of knowledge industries more depends on wide knowledge innovation and knowledge diffusion among different knowledge entities.

●**Pattern III:** In this situation, the city not only has strong competitive advantages in the traditional industries, but also has adequate factors for the knowledge industry development. Then, its development approach towards to the knowledge-based industries is described as "Industry Upgrading". Different from the model of "Industry Transformation", the industry upgrading ought to rely on but not abandon the traditional industries. In other word, industry upgrading is to strengthen knowledge creation and technology innovation in the current industries with the purpose of promoting traditional industries towards the emerging knowledge-based industries. For example, developing modern agriculture, such as ecological agriculture, biological agriculture or aeronautic agriculture may be a good choice for the upgrading of traditional agriculture industry, if a city has competitive advantages in traditional planting agriculture.

●**Pattern IV:** The city has certain advantages in traditional industries, but has no obvious sign of knowledge industries. In other word, the factors for fostering knowledge industries are not sufficient in the city at present. As for the city of this type, an incorrect concept always puzzled the city government that expanding traditional industries based on natural resource without other choices can probably maintain sustainable economic growth. In fact, thoroughly examination of the city's existing industrial advantages and its future prospects is urgent and required. If the city attempt to knowledge-based industries, a suggestion for the development approach can be generalized as "Industrial Extension". It said that the city need search and select several potential industries associated closely with the existing advantageous industries as future key industries. Perhaps these potential industries do not belong to the category of knowledge industies contemporarily, but it is useful to accumulate more resources, such as capital, talent and technology, for the future growth of knowledge industries. A good example is the successful extension from the electronic industry to the high-tech display industry in Dongguan city, Guangdong province of China.

Phase 4: Formulation of detailed action plan for the knowledge industry development

Once the target knowledge-base industries and the

development approach are determined in phase 3, a clear action plan will be discussed and formulated consequently. The case studies in this paper show that the thriving of knowledge industry is due to the balanced development of six essential factors indicated in the Diamond Model, thus concretely thinking of what factors the city should emphasis on and how to increase more of them is the main task in this stage. For example, if the related supporting industry is poor in the city, a special proposal contained in the whole action plan should focus on how to remedy this weakness. In words, the formulation of detailed action plan for the knowledge industry development is suggested for the urban government and the action plan always includes:

- Setting up of a committee that consisted of urban multi-stakeholders and the committee is responsible for the consultation, coordination, execution and examination of the whole plan with the local government.
- Specific approaches and objectives for strengthening each of four essential factors as concerned for the knowledge industry development.
- Annual arrangement of the major projects is accomplished by drafting implement proposal, schedule and expense estimation in each stage of the action plan. In addition, it is needed to divide annual programs into quarterly and monthly maintenance programs as far as possible.
- The formulation of incentive policies and specific regulations for the purpose of enhancing the abundance of six factors concerned, including special funds, land supporting, simplified approval process, et al.
- Additional preparation for monitoring the implementation results and dynamically adjusting schedules during the strategic cycle.

It is obvious that the action plan will be the guidance for the city to develop knowledge industry with a complete strategic management process.

CONCLUSION

In the beginning of 21st century, knowledge city, emerging with the dominancy of knowledge based economy, has become a new mode as well as a new trend of international urban development as its unique advantages (Ergazakis et al., 2004; Yigitcanlar, 2009). It is no doubt that the main driver for the knowledge-based urban development lies in the rapid growth of knowledge economy while the rapid growth of knowledge economy will fundamentally depend on the development of knowledge industries.

In China, some cities have made great achievements in many kinds of knowledge industries, and their successful experiences has provided abundant cases for us in identifying the key factors for the knowledge industry

development. In this paper, we select five cities of them as case studies with the purpose of explaining main factors contributing to their success of knowledge industries. Based on the conclusions obtained from the case studies, an analysis framework for successful knowledge industry development including four phases and related analysis methods is proposed at the end. Obviously, how to develop knowledge industry is always main urban agenda for any city striving for knowledge-base urban development. This framework can offer an integrated approach for a city to identify its advantages as well as challenges for urban knowledge industries development. More in-depth research should incorporate more overseas city cases into the research to improve the analysis framework basically aiming to well adapt for each city. Therefore, the knowledge industry development largely depends on the capacity of taking advantage of opportunities to promote the growth of knowledge industry factors, and minimize the inside and the outside relevant challenges.

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